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AFFDL-TR-78-91
Volume II

RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS
Volume II—PIPSI Users Manual

W.H. Ball and R.A. Atkins, Jr.

BOEING AEROSPACE COMPANY
SEATTLE, WASHINGTON 98124

JULY 1978

TECHNICAL REPORT AFFDL-TR-78-91, VOLUME II
Final Report for Period July 1977—July 1978

AIR FORCE FLIGHT DYNAMICS LABORATORY
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19 REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 18 AFFDL-TR-78-91-VOL-[redacted]2
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER: rept.

4. TITLE (and Subtitle): 6 RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS. VOLUME II. PIPSI USERS MANUAL.

5. TYPE OF REPORT & PERIOD COVERED: 9 FINAL Jul[redacted]77 - Jul[redacted]78

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): 10 W. H./Ball [redacted] R. A./Atkins, Jr

8. CONTRACT OR GRANT NUMBER(s): 15 F33615-77-C-3085

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Boeing Aerospace Company
A Division of The Boeing Company
Seattle, Washington 98124

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 16 2404 0121 17 01

11. CONTROLLING OFFICE NAME AND ADDRESS:
Vehicle Synthesis Branch (AFFDL/FXB)
Air Force Flight Dynamics Laboratory
Wright-Patterson AFB, Ohio 45433

12. REPORT DATE: 11 Jul[redacted]78

13. NUMBER OF PAGES: 99

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 12 104p.

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to U.S. Government Agencies only; Test and Evaluation; Statement applied 10 July 1978. Other requests for this document must be referred to Air Force Flight Dynamics Laboratory (AFFDL/FXB), Wright-Patterson Air Force Base, Ohio 45433

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Installed Engine Performance
Inlet Performance
Nozzle Performance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents the results of a research program to develop computerized preliminary analysis procedures for calculating propulsion system installation losses. These losses include inlet and nozzle internal losses and external drag losses for a wide variety of subsonic and supersonic aircraft configurations up to Mach 3.5. The calculation procedures used in the computer programs, which were largely developed from existing engineering procedures and experimental data, are suitable for preliminary studies of advanced aircraft configurations. Two interactive computer programs were developed (cont)

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during the contract: ~~(1)~~ A propulsion installation effects program that calculates installed performance, using input maps of inlet and nozzle/aftbody characteristics for specific configurations, and ~~(2)~~ a derivative program that allows the user to generate new sets of input maps by perturbations to the geometries of the basic input maps. The work accomplished during the contract is documented in four separate volumes. Volume I is a Final Report discussing the analysis methods and data used to develop the programs, and major technical observations from the study. Volume II is a PIPSI Users Manual, containing documentation of the interactive propulsion installation program. Volume III is the Derivative Procedure (DERIVP) Users Manual, documenting the methods and usage of the derivative procedure. Volume IV is the library of input maps.

FOREWORD

This report documents the work accomplished during USAF Contract No. F33615-77-C-3085. The work consisted of developing an interactive PIPSI computer program, developing an interactive derivative computer program, and developing and documenting supporting data libraries. The work was accomplished in three phases. As part of the work accomplished in Phase I of the contract, the interactive PIPSI program was completed and delivered to the Air Force. As part of Phase II work, derivative parameters were selected and development work was completed on the derivative program. During Phase III a library of inlet and nozzle/aftbody characteristics was prepared, test cases were completed, documentation was accomplished, and final programs were delivered to the Air Force. The program was conducted under the direction of the Vehicle Synthesis Branch, Air Force Flight Dynamics Laboratory, Air Force Systems Command. Mr. Gordon Tamplin was the Air Force Program Monitor.

The program was initiated on 17 July 1977 and draft copies of the final reports were submitted for approval on 15 May 1978.

Mr. W. H. Ball was Program Manager for The Boeing Company. The following individuals contributed significantly to the work accomplished during this contract: R. A. Atkins, Jr., computer programming; T. E. Hickcox, inlet derivative procedure development; E. J. Kowalski, inlet configurations and performance; and J. E. Petit and R. M. Trayler, nozzle/aftbody procedure and configurations.

TABLE OF CONTENTS

		Page
I	Introduction	1
II	Engineering Description of PIPSI Program	5
III	Files Required to Run	21
IV	User Options Available	45
V	Program Execution Sequence	51
VI	Examples of Tabular Data Files	53
VII	Example of a Terminal Session	63
VIII	Nomenclature for Input and Output	67
IX	Sample Output	73
X	Flow Charts	83

LIST OF ILLUSTRATIONS

		PAGE
1.	PIPSI Data Flow	3
2.	Preliminary Analysis Process Using PIPSI	6
3.	Inlet Procedure	7
4.	Format for the Inlet Performance Characteristics	9
5.	PIPSI Performance Calculation for an External-Compression Inlet	10
6.	PIPSI Performance Calculation for a Mixed-Compression Inlet	12
7.	Data Format for Nozzle/Aftbody Drag	16
8.	Format for C_{F_G} Maps	18
9.	Examples of Four Table Types	27
10.	Engine Data File Structure	29
11.	Engine Deck Structure	30
12.	Typical Set of Control Cards	51
13.	PIPSI Main Program	84
14.	Subroutine COMP	86
15.	Subroutine BYPM5	90
16.	Subroutine BYSPL	91
17.	Subroutine INDRAG	93
18.	Subroutine RDATA	95
19.	Subroutine TSQNCE	97

LIST OF NOMENCLATURE AND SYMBOLS

A^*	Sonic area, in^2
A	Area, in^2
A_c	Inlet capture area, in^2
A_o	Local stream tube area ahead of the inlet, in^2
A_{o_I}	Free-stream tube area of air entering the inlet, in^2
$\mathcal{R}$	Aspect ratio, W_c/H_c for inlets, W_9/H_9 for nozzles, dimensionless
C_D	Drag coefficient, $\frac{D}{q\,A_{ref.}}$, dimensionless
C	Sonic velocity; ft/sec.
C-D	Convergent-divergent
$C_{D_{ADD}}$	Additive drag coefficient, $C_{D_{ADD}} = \frac{D_{ADD}}{q\,A_c}$, dimensionless
$C_{D_{A10}}$	Afterbody drag coefficient, $\frac{DRAG}{q\,A_{10}}$, dimensionless
$C_{D_{Base}}$	Base drag coefficient $\frac{(P_b - P_\infty)\,A_{base}}{q\,A_{10}}$, dimensionless
$C_{D_{A10-A9}}$,	
$C_{D_{PAP}}$	Drag coefficient, $\frac{D}{q_o\,(A_{10} - A_9)}$, based on projected area, dimensionless
C_{D_S}	Scrubbing drag coefficient, $\frac{DRAG}{q\,A_{10}}$, dimensionless
C_{f_G}	Thrust coefficient, $\frac{F_g}{\frac{W}{g}\cdot(V_{cp})}$ dimensionless
C_V	Nozzle velocity coefficient, dimensionless
Conv.	Convergent

D	Drag, lb.; Hydraulic Diameter, $\frac{4A}{P}$, in., diameter, in.
F	Thrust, lb.
F_N	Net thrust, lb.
F_{N_A}	Installed net thrust, lb.
F_{g_i}	Ideal gross thrust (fully expanded), lb.
f/a	Fuel/air ratio, dimensionless
g	Gravitational constant, ft/sec^2
h	Enthalpy per unit mass, BTU/lb.; height, in.
h_{fan}	Enthalpy of fan discharge flow, BTU/lb
h_{pri}	Enthalpy of primary exhaust flow after heat addition, BTU/lb
h_t	Throat height, in^2
IMS_T	Integral mean slope parameter, truncated $$IMS_T = -\frac{1}{(1 - A_9/A_{10})} \int_{A_9/A_{10}}^{1.0} \frac{d(A/A_{10})}{d(L/D_{eq})} \, d(A/A_{10})$$
L	Length, in.
M	Mach number, dimensionless
P	Static pressure, lb/in^2 , perimeter, in.
P_r	Relative pressure,; the ratio of the pressures p_a and p_b corresponding to the temperatures T_a and T_b, respectively, along a given isentrope, dimensionless
P.S.	Power setting
P_T	Total pressure, lb/in^2
Q	Effective heating value of fuel, BTU/lb.

q	Dynamic pressure, lb/in^2
R	Gas constant
R, r	Radius, in.
R_F	Total pressure recovery
SFC	Specific fuel consumption
SFC_A	Installed specific fuel consumption
T	Temperature, ^oR
V	Velocity, ft/sec
W	Mass flow, lb/sec
W_{BX}	Bleed air removed from engine, lb/sec.
W_C,	Corrected airflow, lb/sec. $\frac{w\sqrt{\theta}}{\delta}$
W_f	Weight flow rate of fuel, lb/sec.
W_2	Weight flow rate of air, primary plus secondary, lb/sec.
W_8	Primary nozzle airflow rate, lb/sec.
x	Length, in.
α	Angle of attack; convergence angle of nozzle, degrees
γ	Ratio of specific heats, dimensionless
δ_{T_2}	Pressure correction factor, $P_{T_2}/P_{STD.}$
ϵ	Diffuser loss coefficient, $\frac{\Delta P_T}{q}$, dimensionless
θ_{T_2}	Temperature correction factor, $T_{T_2}/T_{STD.}$

LIST OF NOMENCLATURE AND SYMBOLS (Concluded)

θ_N	2-D Nozzle wedge half-angle
θ_P	Round Plug nozzle half-angle
η_B	Burner efficiency, dimensionless
ν	Kinematic viscosity, $ft^2/sec.$
ρ	Density, lb/ft^3

SUBSCRIPTS

amb	Ambient
AB	Afterbody
B	Burner
B_X	Bleed airflow extracted from the engine
b, base	Base flow region
BP	Bypass
BLC	Boundary layer bleed
btail	Boattail

SECTION I

INTRODUCTION

As part of the work accomplished under Air Force Contract F33615-77-C-3085, an interactive computer program has been developed to calculate installed propulsion system performance. The computer program has been given the designation "Performance of Installed Propulsion Systems - Interactive" (PIPSI). The intended use of the program is to provide the AFFDL/FXB with the capability to make quick analyses of installed propulsion system performance, accounting for the effects of inlet total pressure recovery losses and drag, nozzle internal losses, and nozzle/aftbody drag. To reduce the time required to generate installed performance, the program can use a library of computer stored tables representing the performance characteristics of a wide variety of inlets and nozzle/aftbodies or a set of tables can be prepared for a specific configuration. Uninstalled engine data is supplied as program input in tabular input tables (Mark 12 format).

The purpose of this Manual is to provide a user oriented description of the program input requirements, program output, deck setup, and operating instructions. It also provides examples of tabular input tables that can be used as a test case to exercise the major calculation paths of the PIPSI program. An example of the terminal output from a typical calculation session is also included.

The PIPSI computer program has been developed with the following characteristics and limitations:

1. Assumes the use of the Network Operating System/- Batch Environment (NOS/BE).
2. Runs on either the CDC6600 or the Cyber-74 system
3. Runs interactively using INTERCOM.
4. Is coded in FORTRAN IV compatible with the FTN compiler.
5. Compiles, loads, and runs in less than 60,000 octal words.

The PIPSI program utilizes external data files as well as user supplied terminal input for generating installed engine performance data.

Figure 1 shows the data flow for the PIPSI program.

All tabular data are input to the program via previously built disk files. The user exercises various program options using an interactive mode of data input.

The output of the program is via the user terminal and an output disk file. Once the user has ascertained from the terminal outpu hat a data case has been executed, the detailed output may be disposed t an auxiliary printer by utilizing control statements.

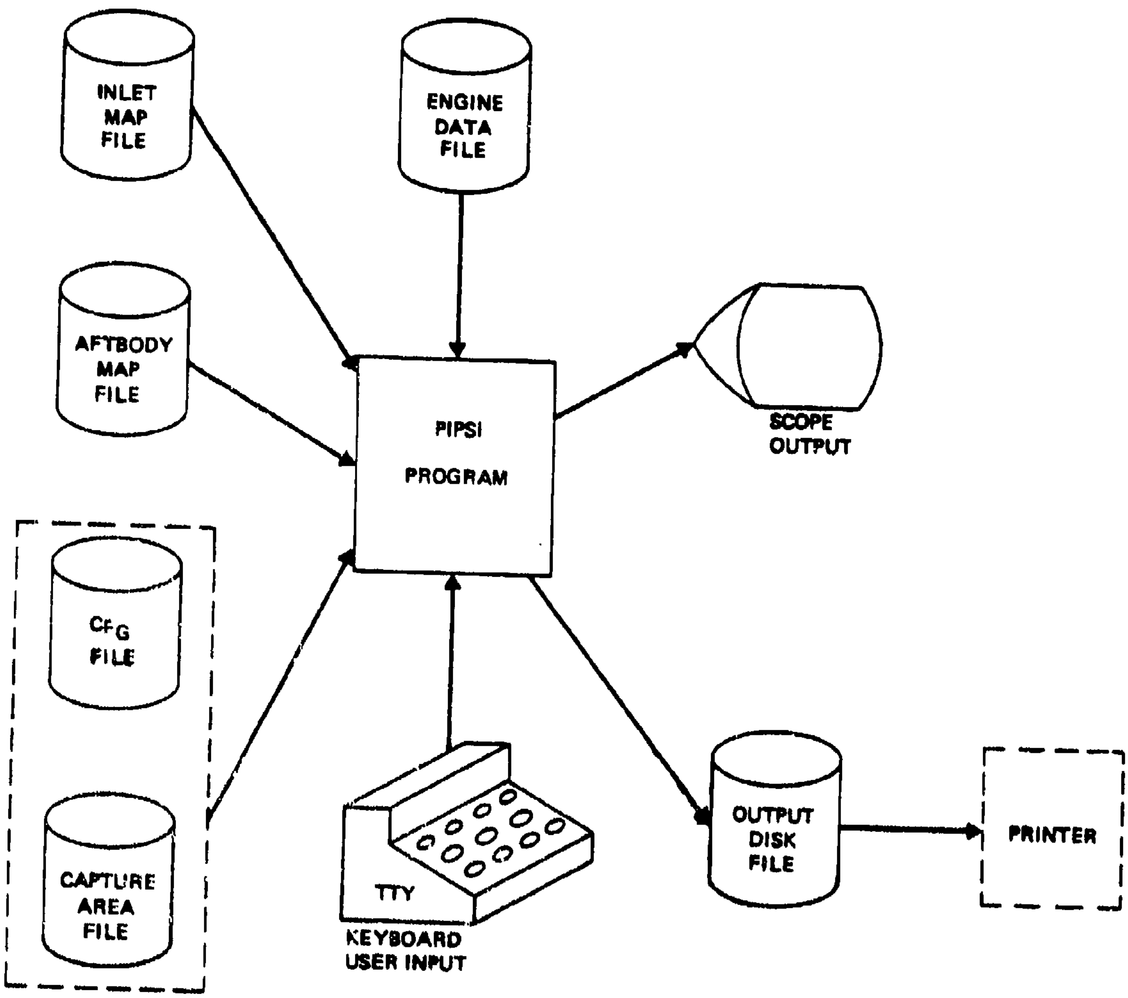


Figure 1. PIPSI Data Flow

SECTION II

ENGINEERING DESCRIPTION OF PIPSI PROGRAM

The use of the PIPSI Program is illustrated in Figure 2. The program is composed of four main parts:

1) Inlet Files
2) Nozzle/Afterbody Drag and Gross Thrust Coefficient Files
3) Uninstalled Engine Data Files
4) Computer Operation Subroutines

2.1 INLET SUBPROGRAM

The operation of the inlet subprogram is shown schematically in Figure 3. The connecting link between the engine data and the inlet subprogram is engine-plus-secondary corrected airflow. The sizing routine permits the inlet to be sized for operation at a desired inlet mass flow ratio and recovery using the design engine airflow demand. A specified capture area size can also be input, if desired, instead of requiring the program to calculate the size.

2.1.1 Inlet Performance

Inlet performance maps are input data to the inlet subprogram. This subprogram sizes the inlet capture area (if it is required) and converts the inlet performance maps into total pressure recovery and inlet drags that are matched to the corrected airflow demand of the engine.

The inlet input requires fourteen tables of input data which describe the performance characteristics of the inlet. Engineering data obtained from wind tunnel tests and theoretical calculations are used to obtain the

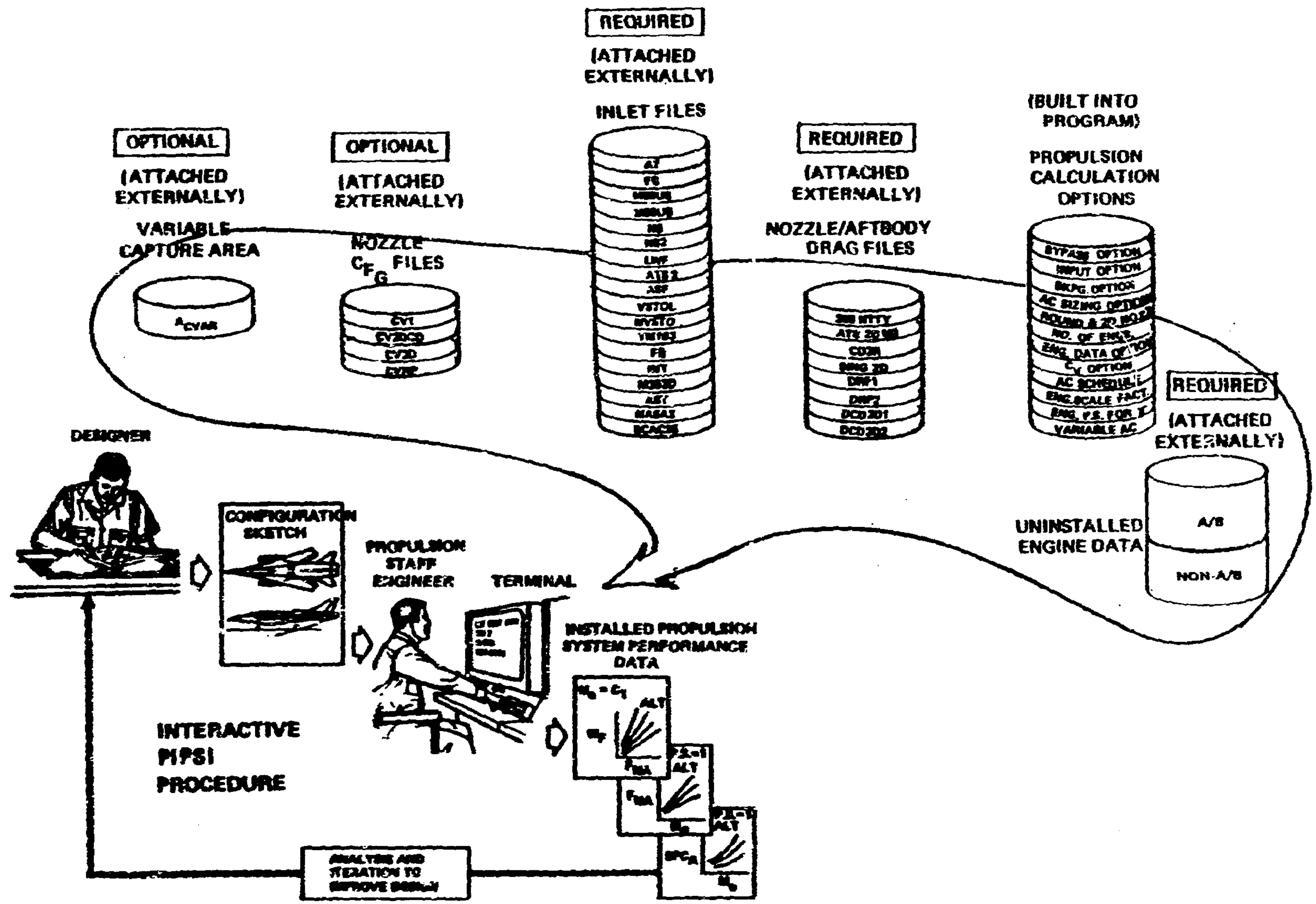


Figure 2 Preliminary Analysis Process Using PIPSI

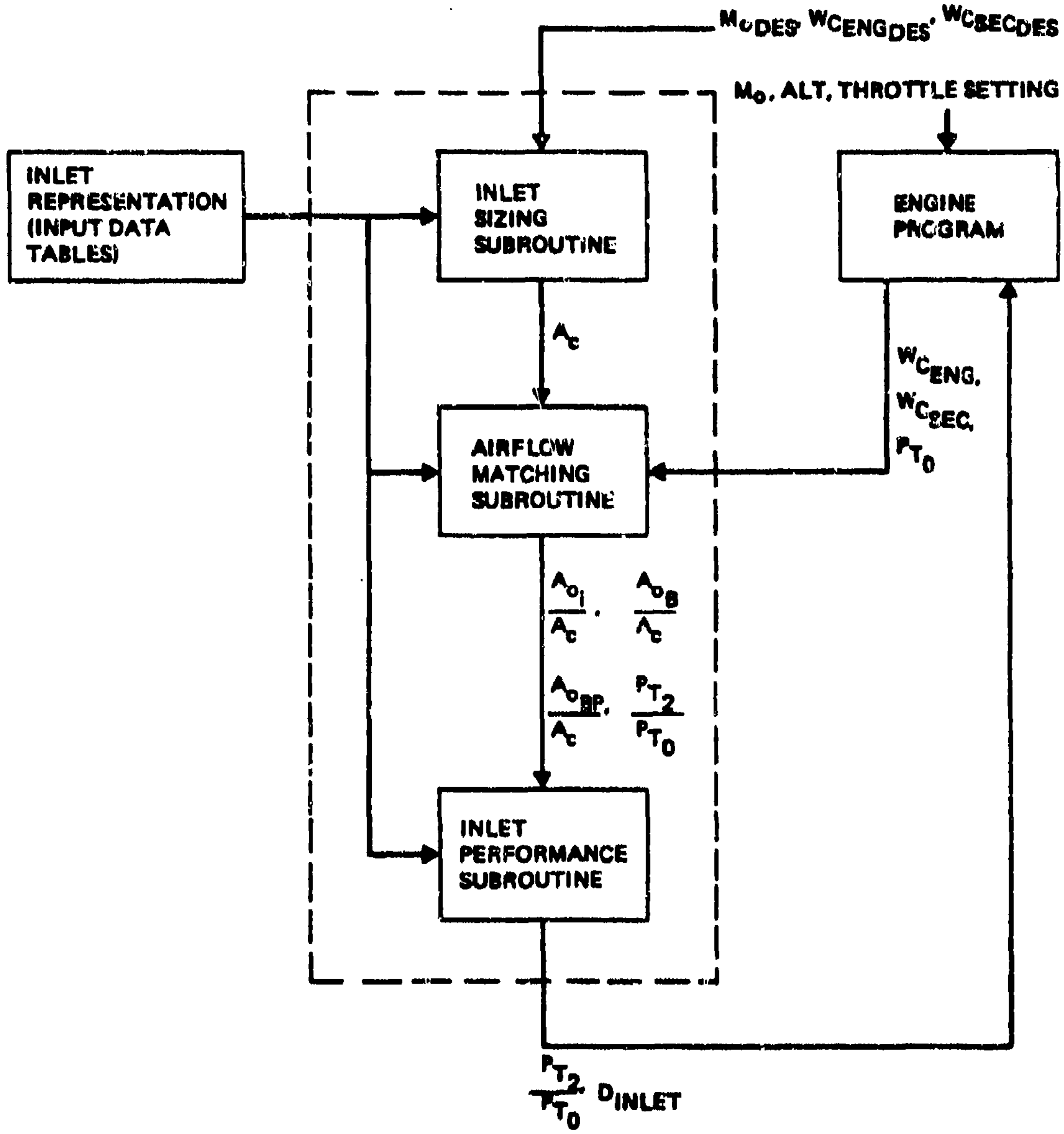


Figure 3, Inlet Procedure

inlet performance characteristics. The format for the inlet data is shown in Figure 4. Data taken from these engineering plots are punched on cards as part of the inlet library for input into PIPSI.

The inlet subroutine recognizes three modes of inlet operation: low-speed, external compression, and mixed compression. The low-speed mode is used only at very low Mach numbers, e.g., takeoff conditions, when only high engine power settings are likely to be of interest and inlet drag is negligible. The external-compression mode is used over the remaining Mach number regime for external-compression inlets. It is also used for the remaining subsonic regime and supersonic Mach numbers up to the starting Mach number for mixed-compression inlets. The mixed-compression mode is used at or above the starting Mach number for mixed-compression inlets.

a) External-Compression Inlets. The PIPSI calculation of recovery and drag for an external-compression inlet is illustrated in Figure 5. The required performance maps are input as tables, as indicated. Table 1 is used to represent the effect of the airplane flow field on the local Mach number seen by the inlet. Table 2A gives the basic recovery/mass-flow-ratio characteristics of the inlet. The minimum Mach number for which data is input in Table 2A is taken by the program to be $M_{o_{min}}$, below which only the lowspeed mode is used.

In the low-speed mode, recovery is read directly out of Table 2B as a function of local Mach number only, and inlet drag is neglected.

If the local Mach number exceeds $M_{o_{min}}$, the recovery and mass flow ratio are determined using Table 2A, Table 7 (which gives the scheduled bypass flow, if any, as a function of engine mass flow ratio), and the engine corrected airflow demand. PIPSI iterates to solve simultaneously for the matchpoint recovery and inlet mass flow ratio, as well as the engine mass flow ratio and scheduled bypass flow. If the indicated buzz (Table 2D) or distortion (Table 2E) limits are exceeded, an appropriate warning message will appear, but

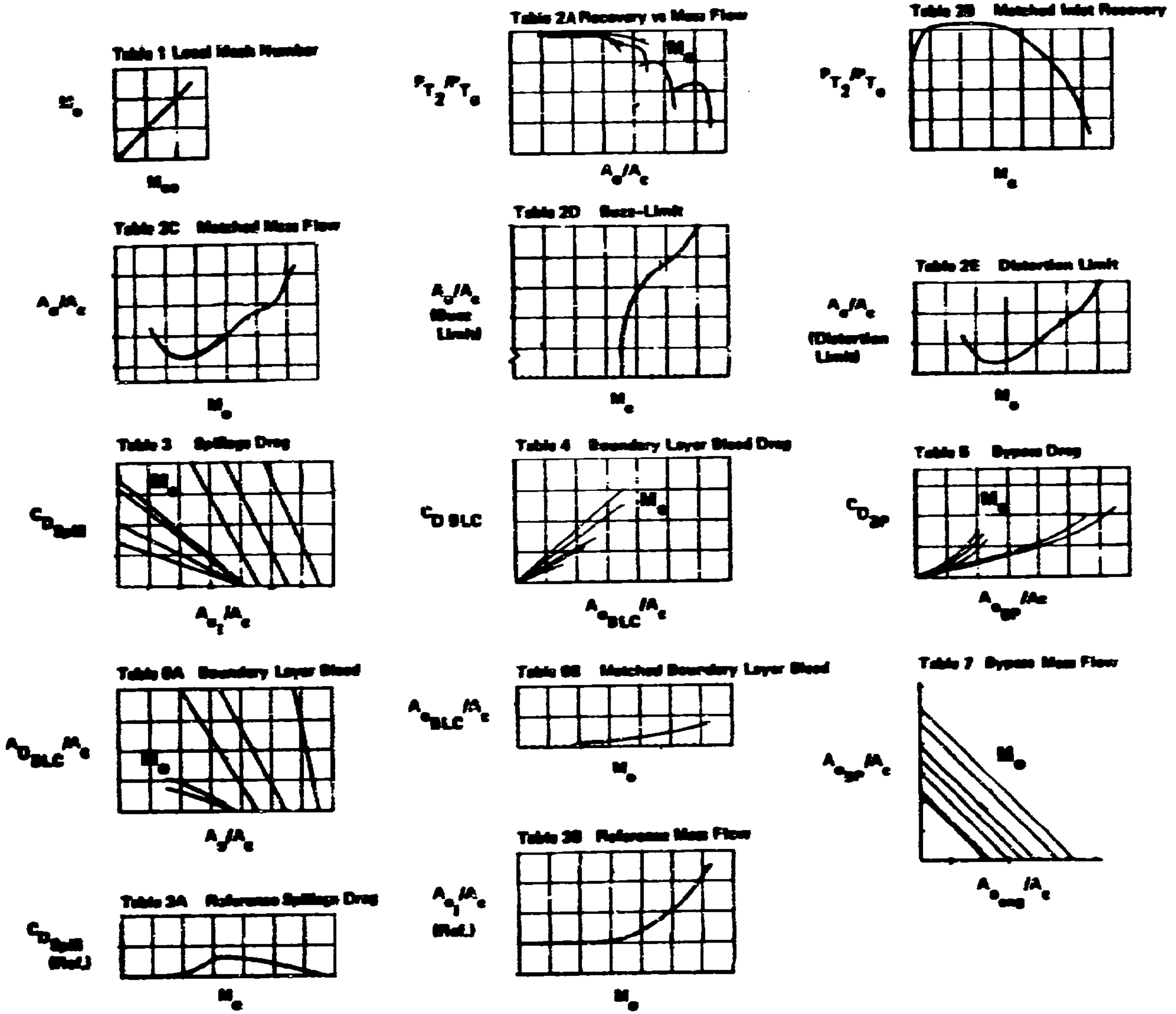


Figure 4. Format for the Inlet Performance Characteristics

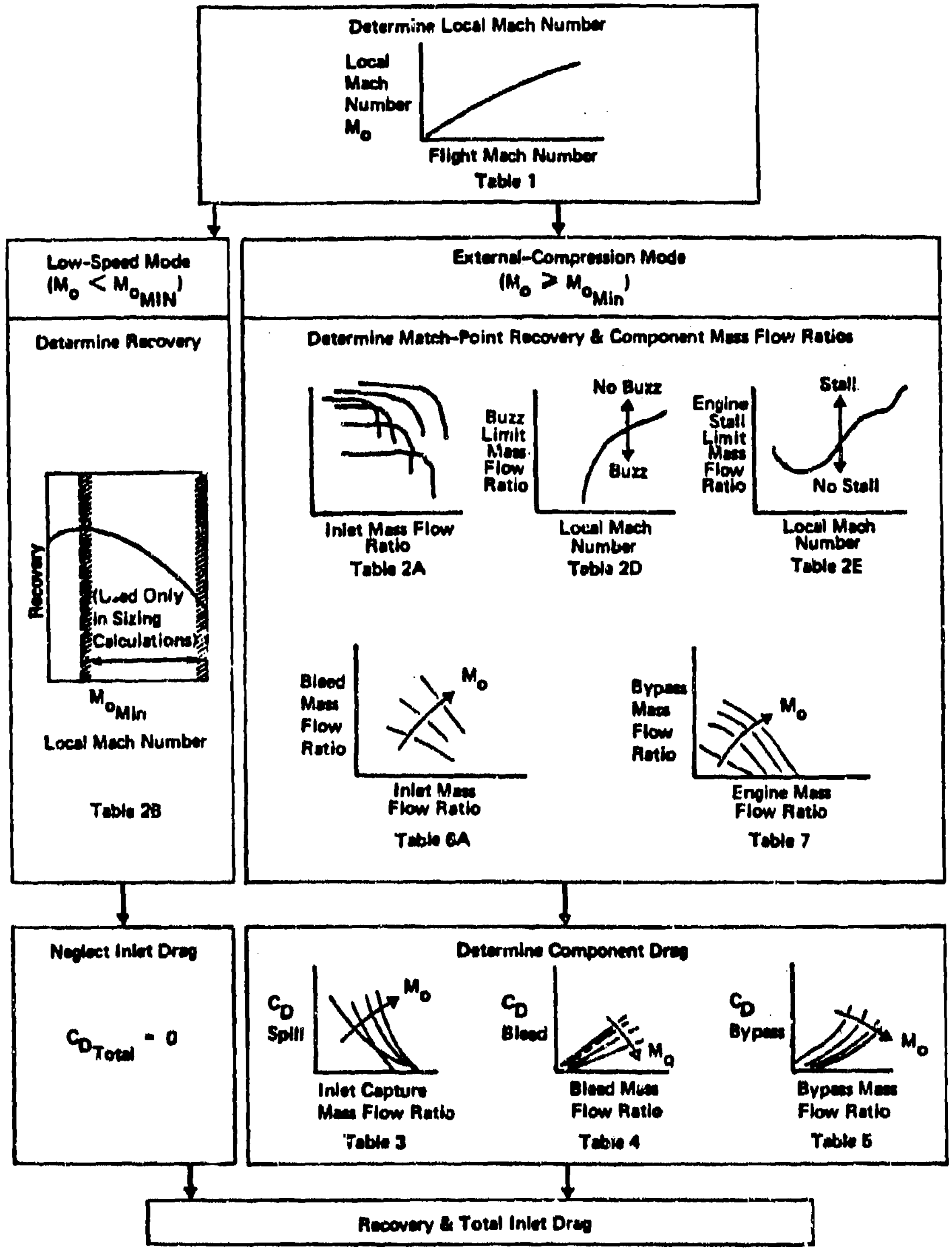


Figure 5. PIPSI Performance Calculation for an External-Compression Inlet

no fatal error will result. The bleed mass flow associated wtih the calculated inlet mass flow ratio is determined from Table 6A.

After the required mass flow ratios are determined, spillage, bleed, and bypass drags are found from Tables 3, 4, and 5, respectively. Spillage drag is the incremental change in additive drag and pressure drag on the airplane due to inlet operations at mass flow ratios less than a reference mass flow ratio. The bleed and bypass drags include door drags as well as momentum loss of the airflow.

b) Mixed-Compression Inlets. The performance calculation for a mixed-compression inlet is illustrated in Figure 6. Below the starting Mach number M_S, the low-speed mode and external compression mode are used in the same way as in the case of an external-compression inlet. The mixed-compression mode, used at or above M_S, is based on the assumption that a closed-loop bypass system is available to remove all excess air. Thus, except for the case of excessive engine airflow demand, the inlet mass flow ratio, bleed flow, and recovery may all be scheduled as a function of local Mach number only; the bypass system compensates for changes in engine airflow demand.

If the corrected airflow delivered by the inlet is inadequate to meet the engine demand at the scheduled recovery, the program will permit the inlet to operate at an excessive supercritical margin. The recovery will be lowered sufficiently to match the engine corrected airflow demand, and an appropriate message will warn the user of an undersized inlet.

Inlet spillage, bleed, and bypass drag are found using Tables 3, 4, and 5, as in the external-compression mode. The data in these tables for Mach numbers equal to or greater than M_S apply only for started inlet operation.

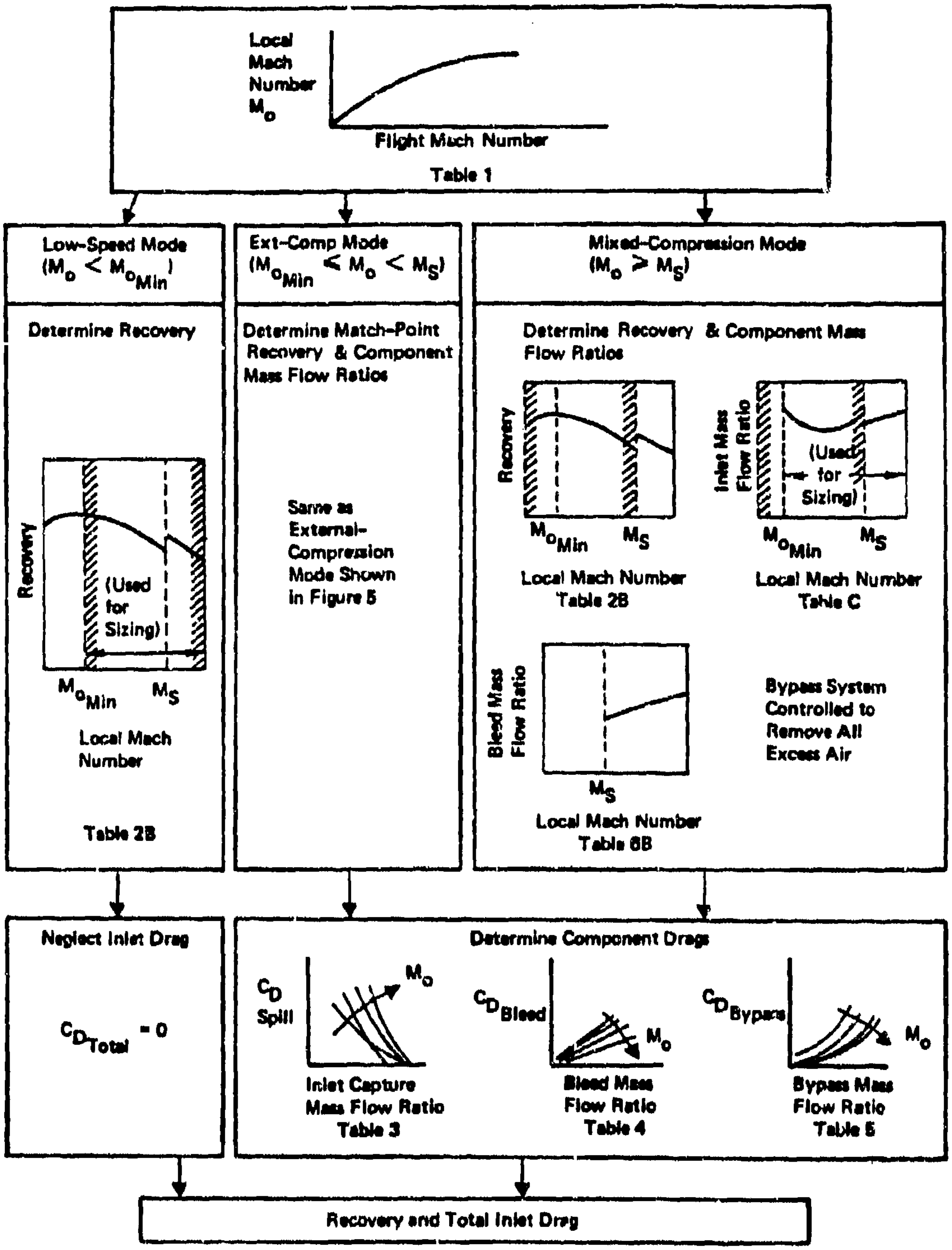


Figure 6. PIPSI Performance Calculation for a Mixed-Compression Inlet

2.1.2 Inlet Sizing

The inlet sizing procedure in the computer program determines the inlet capture area required to match the largest engine airflow demand at each Mach number. From these calculated inlet sizes, the largest required size is selected as the inlet capture area. For sizing calculations, an input curve (Table 2C) of recommended (matched) inlet airflow variations (A_0/A_C) vs. M_0 and an input curve (Table 2B) of recommended (matched) inlet total pressure recovery vs. M_0 are used to determine the required capture area variation with Mach number. These parameters are used in the following equation to calculate capture area, A_C:

$$A_c, IN^2 = \frac{A_{o\,eng}}{(A_o/A_c)_{matched}} = \frac{\frac{(W\sqrt{\theta})}{\delta} \left(P_{T2}/P_{To} \right)_{matched} \; (A/A^*)_o}{.343 \left(A_o/A_c \right)_{matched}}$$

2.1.3 Inlet Reference Condition

For purposes of aero-propulsion thrust/drag bookkeeping, a reference mass flow ratio is employed. This reference mass flow ratio is always shown in inlet input Table 3D. It represents the inlet mass flow ratio, A_{0_I}/A_C, at which the spillage drag is defined as zero. This reference provides the zero drag reference base for the input spillage drag variations vs. A_{0_I}/A_C at each Mach number input as Table 3. The reference mass flow ratio is selected to be a mass flow ratio at or near the point of maximum inlet mass flow ratio at each M_0. At this point, no further throttle-dependent inlet airflow variations would be expected. Therefore, at this mass flow ratio it is logical to include the drag of the spilled airflow in the airplane drag polar.

For users who prefer to use a mass flow ratio of 1.0, an option is included in the computer program to add the incremental reference spillage drag to the spillage drag input data of Table 3, thereby creating a reference mass flow ratio equal to 1.0.

2.1.4 Inlet Recovery Correction

The engine input provides the required data for inlet drag, inlet recovery, nozzle afterbody drag and nozzle coefficient calculations. The engine section of the PIPSI program calculates only the changes in internal performance due to changes in inlet recovery. Changes in inlet recovery produce a directly proportional change in nozzle pressure ratio, airflow, and fuel flow because the nozzle throat area does not change. Furthermore; it is assumed that engine data is calculated with MIL STD 5008 B recovery and all inlet recovery changes are made relative to that value. Provisions are also built into the program to allow the user to input a reference recovery schedule vs. Mach number that is different from MIL STD 5008B if he desires to do so. Thermodynamic data from Keenan and Keye tables has been "curve-fitted" and subroutines are provided to calculate the thermodynamic properties of the exhaust gases.

The calculation procedure is as follows: for each altitude, Mach number, and power setting, the net thrust (F_N), fuel flow (W_F), corrected airflow ($W\sqrt{\theta_2}/\delta_2$), nozzle throat area ($A_8$), nozzle exit area ($A_9$), and nozzle thrust coefficient (C_{F_G}) are given.

Standard atmosphere and MIL Standard 5008 B inlet recovery are used to calculate the airflow at the engine face and gross thrust is calculated for the given engine data before any changes in inlet recovery.

$$F_{G\,OLD} = F_N + \frac{W V_\infty}{g}$$

The desired inlet recovery is obtained from the inlet subprogram and the engine gross thrust is first calculated with MIL Standard recovery and then with the calculated recovery. The new value of gross thrust is then found by ratio

$$F_{G\,NEW} = F_{G\,OLD} \frac{F_{G2}}{F_{G1}}$$

The ratio procedure is used to minimize any inaccuracies that may be caused by assuming burner efficiency (η_B) is constant for all engine operating conditions.

The net thrust and fuel flow after correction for inlet recovery are:

$$F_{N_R} = F_{G\,NEW} - \frac{W V_\infty}{g} \frac{R_F}{R_{F\,MIL}}$$

$$W_{FR} = W_F \frac{R_F}{R_{F\,MIL}}$$

and the installed propulsion system thrust and SFC:

$$F_{NA} = F_{NR} - D_{INLET} - D_{NOZ} + D_{NOZ\,REF.}$$

$$SFC_A = \frac{W_{FR}}{F_{NA}}$$

2.2 NOZZLE SUBPROGRAM

The purpose of the nozzle/afterbody drag and C_{F_G} input data and calculation subprograms is to calculate nozzle internal losses (C_{F_G}) and nozzle/afterbody drag.

2.2.1 Nozzle/Afterbody Drag

The nozzle/afterbody drag is computed using maps which represent the afterbody drag characteristics (Figure 7) as a function of A_{10}/A_9 and M_0, external input geometry and engine data. Engine data obtained internally from the engine subprogram include nozzle throat area, nozzle pressure ratio, freestream conditions, and ideal gross thrust. An essential geometry input is the nozzle exit area, A_9, which is required for boattail drag computation. This parameter is obtained in either of two ways:

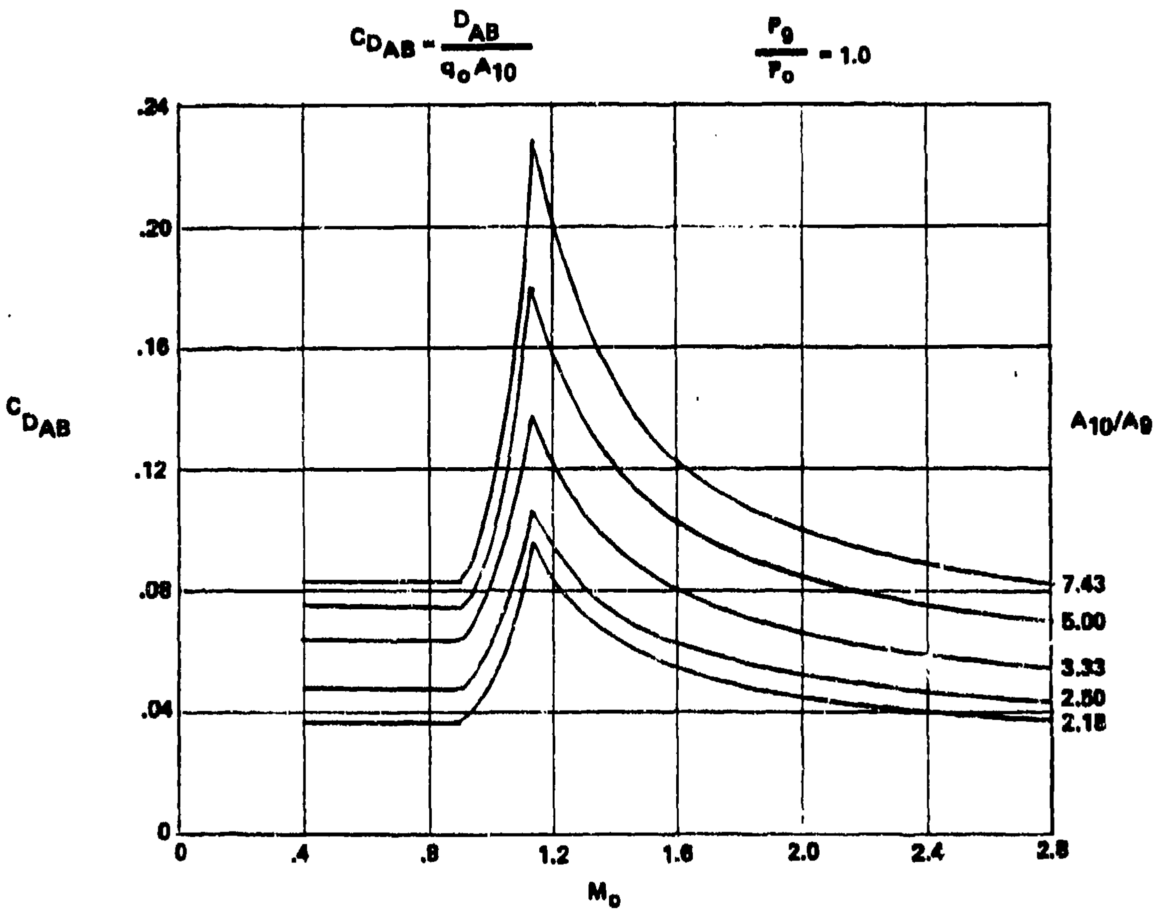


Figure 7. Data Format for Nozzle/Aftbody Drag

1. From the engine subprogram when the existing nozzle data are used;
2. From a calculation of fully-expanded A_9 as a function of nozzle total pressure ratio for wedge and plug nozzles.

The program currently has built in for the variation of base pressure, P_b/P_∞, as a function of freestream Mach number. This is then used to calculate $C_{D_{Base}}$.

Fully-expanded nozzle/aftbody drag coefficient is obtained from tables such as those illustrated in Figure 7. The drag coefficient is obtained as a function of the ratio of nozzle exit to maximum cross-sectional area, A_9/A_{10}, and free-stream Mach number.

2.2.2 Nozzle Gross Thrust Coefficient

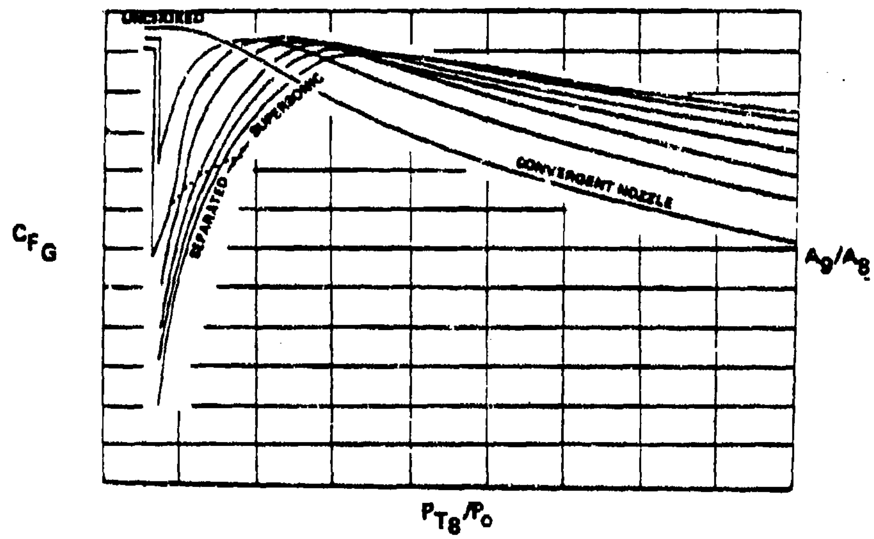
The nozzle gross thrust coefficient input data maps are used to provide a means for correcting uninstalled engine data for the effects of nozzle internal performance that is different from the nozzle internal performance used in generating the uninstalled engine data.

Two different types of nozzle C_{F_G} maps are provided, as shown in Figure 8. Figure 8a shows the data input format for a round nozzle and Figure 8b shows the data input format for two-dimensional nozzles. For round nozzles, the nozzle area ratio, A_9/A_8 is calculated from tabulated input values provided along with nozzle pressure ratio, P_{T_8}/P_o, as part of the engine data.

For use with the two-dimensional nozzle C_{F_G} input, the engine power setting and nozzle pressure ratio are obtained from the engine input data by procedures programmed into the engine performance subprogram.

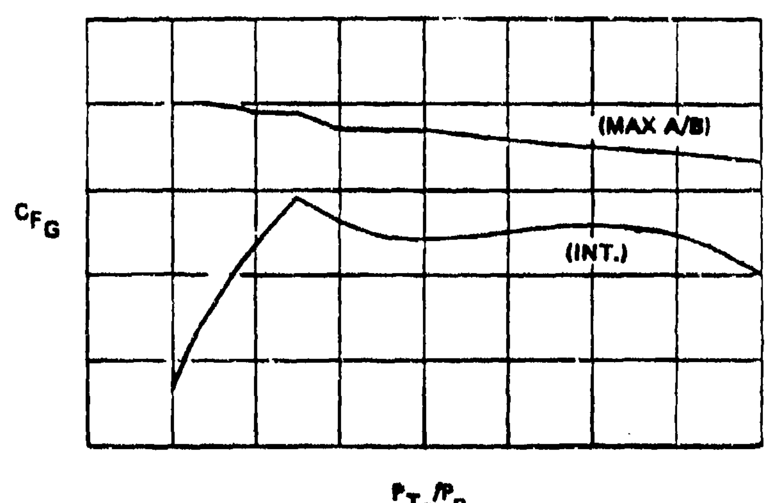
The data input table format for the round nozzle (Figure 8a) provides nozzle gross thrust coefficient as a function of nozzle total pressure ratio and area ratio. In the case of two-dimensional nozzles, however, the nozzle gross thrust coefficient (Figure 8b) is input as a function of

ROUND NOZZLES



(a)

TWO-DIMENSIONAL NOZZLES



(b)

Figure 8. Format for C_{F_G} Maps

nozzle total pressure ratio for maximum afterburning and intermediate (dry) power settings. The two-dimensional nozzle input data format is based on the assumption that a variable area nozzle will be used which will be scheduled to provide an optimum variation of area ratio as a function of nozzle pressure ratio. Fundamentally, the gross thrust coefficient input data for both the round and two-dimensional nozzles could both be presented using the same format; in which case the data format for the round nozzle provides more generality because it allows for the selection of nozzle area ratio, A9/A8. However, the lack of available data covering a wide range of two-dimensional nozzle area ratios plus the ability of the two-dimensional nozzle variable geometry to achieve a wider range of nozzle area ratios (and hence, be able to closely approach an optimum area ratio schedule) led to the selection of the simpler nozzle performance format for the two-dimensional nozzle shown in Figure 8b. If the future need arises to use the same format for both nozzle types the program can easily be modified to accomplish this. As an alternative, the user can enter the two-dimensional data in the same format as the round nozzle data and, during the PIPSI interactive terminal session, enter the input code that the nozzle type is a round rather than two-dimensional nozzle.

SECTION III

DATA FILES REQUIRED TO RUN PIPSI

There are a maximum of 5 external data files needed as input. These include:

1) Engine Data File (Sec 3.2)
2) Inlet Map File (Sec 3.3)
3) Afterbody Map File (Sec 3.4)
4) Nozzle Thrust Coefficient (CFG) File (Sec 3.5)
5) Capture Area File (Sec 3.6)

The first three files are always required as input in order to run PIPSI. The CFG file and capture area file are optional and apply only if the user asks for them when responding to an interactive prompt. In either case, if a file is going to be used during a PIPSI execution, it must be attached (see Section V) prior to program execution. The record structure of these files is identical to that of the Derivative Procedure Program (AFFDL-TR-78-91-Vol. III).

3.1 TABLE FORMAT

The values in the tables are stored on disk in a 10F7.0 card format. The meanings of the quantities placed in a card image differ depending on the type of table. There are four table types:

a) One dimensional = Type 1
b) Two dimensional (symmetric) = Type 2
c) Two dimensional (non-symmetric) = Type 3
d) Three-dimensional = Type 4

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3.1.1 One Dimensional Table Definition

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Name	A7
8-14	Number of X Values	F7.0

Card 2	X Values	
Cols.		
1-7	X_1	F7.0
8-14	X_2	F7.0
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
64-70	X_{10}	F7.0

Card 3	Table Values	
Cols.		
1-7	$f(x_1)$	F7.0
8-14	$f(x_2)$	F7.0
.	.	.
.	.	.
64-70	$f(x_{10})$	F7.0

3.1.2 Two-Dimensional Table Definition (Symmetric)

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Title	A7
8-14	Number of X Values	F7.0
15-21	Number of Y Values	F7.0

Card 2	Y Values	
Cols.		
1-7	Y_1	F7.0
8-14	Y_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	Y_{10}	F7.0

Card 3	X Values	
Cols.		
1-7	X_1	F7.0
8-14	X_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	X_{10}	F7.0

Card 4	Table Values for Y_1, and all X Values	
Cols.		
1-7	$f(x_1,y_1)$	F7.0
8-14	$f(x_2,y_1)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$f(x_{10},y_1)$	F7.0

Card 5	Table Values for Y_2, and all X Values	
Cols.		
1-7	$f(x_1,y_2)$	F7.0
8-14	$f(x_2,y_2)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$f(x_{10},y_2)$	F7.0

Etc. for additional Y values

3.1.3 Two-Dimensional Table (Non-Symmetric)

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Name	A7
8-14	Number of Y values	F7.0

Card 2	Number of X Values for A Particular Y Value	
Cols.		
1-7	NX (Y_1)	F7.0
8-14	NX (Y_1)	F7.0
.	.	.
.	.	.
.	.	.
.	.	.
64-70	NX (Y_{10})	F7.0

Card 3	Y Values	
Cols.		
1-7	Y_1	F7.0
8-14	Y_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	Y_{10}	F7.0

Card 4	X Values for Y_1	
Cols.		
1-7	$X_1(y_1)$	F7.0
8-14	$X_2(y_1)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$X_{10}(y_1)$	F7.0

Card 5 Table Values for (X_1-X_{10}, Y_1)

Cols.		
1-7	$f(X_1,Y_1)$	F7.0
8-14	$f(X_2,Y_1)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$f(X_{10},Y_1)$	F7.0

Card 6 X Values for Y_2
(See Card 4)

Card 7 Table Values for (X_1-X_{10},Y_2)
(See Card 5)

Etc. for all Y values

3.1.4 Three-Dimensional Table Definition

Card 1	table definition card	Format
Cols.		
1-7	table name	A7
8-14	NX = number of X values	F7.0
15-21	NY = number of Y values	F7.0
22-28	NZ = number of Z values	F7.0

Card 2	Z Values	
Cols.		
1-7	Z_1	F7.0
8-14	Z_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	Z_{10}	F7.0

<u>Card 3</u>	Y Values	
Cols.		
1-7	Y_1	F7.0
8-14	Y_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	Y_{10}	F7.0
<u>Card 4</u>	X Values	
Cols.		
1-7	X_1	F7.0
8-14	X_2	F7.0
.	.	.
.	.	.
.	.	.
64-70	X_{10}	F7.0
<u>Card 5</u>	Table Values for Y_1, Z_1, and all X Values	
Cols.		
1-7	$f(X_1,Y_1,Z_1)$	F7.0
8-14	$f(X_2,Y_1,Z_1)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$f(X_{10},Y_1,Z_1)$	F7.0
<u>Card 6</u>	Table Values for Y_2,Z_1 and all X Values	
Cols.		
1-7	$f(X_1,Y_2,Z_1)$	F7.0
8-14	$f(X_2,Y_2,Z_1)$	F7.0
.	.	.
.	.	.
.	.	.
64-70	$f(X_{10},Y_2,Z_1)$	F7.0

Etc. until Y Values have been gone through

Card 5 + NX	Table Values for Y_1, Z_2	
Cols.	and all X Values	
1-7	$f(X_1, Y_1, Z_2)$	F7.0
8-14	$f(X_2, Y_1, Z_2)$	F7.0
.	.	.
.	.	.
.	.	.

Etc. until all Y and Z Values have been gone through

3.1.5 Table Examples

Examples of tables in each of the 4 formats are shown in Figure 9.

Table 2E6

.55	.7	.8	1.2	1.6	2.0
1.055	.935	.89	.846	.89	.935

Table Type 1

Tables 7. 8.

0.	.8489	.85	1.0	1.2	1.4	1.7	2.20
0.	.04	.08	.12	.16	.20	.24	
0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	
0.	.062	.125	.198	.28	.38	.50	
0.	.05	.10	.156	.217	.29	.375	
0.	.036	.075	.117	.162	.22	.29	
0.	.03	.062	.097	.135	.185	.241	
0.	.025	.052	.081	.116	.16	.216	
0.	.02	.045	.074	.11	.153	.21	

Table Type 2

Figure 9. Examples of Four Table Types (continued)

Table 2A6

7.	6.	7.	7.	8.	9.			
.55	.70	.85	1.20	1.60	2.0			
.7	.8	.9	1.0	1.055	1.075	1.1		
.9915	.991	.985	.969	.95	.933	.875		
.6	.7	.8	.9	.95	.97			
.99	.99	.985	.974	.945	.90			
.5	.6	.7	.8	.85	.875	.905		
.99	.99	.989	.983	.975	.962	.90		
.5	.6	.7	.8	.85	.875	.902		
.98	.979	.977	.973	.967	.955	.90		
.500	.600	.700	.800	.850	.875	.885	.890	
.976	.970	.965	.958	.955	.940	.925	.900	
.5	.6	.7	.8	.9	.93	.935	.943	.95
.958	.953	.949	.944	.935	.925	.92	.900	.85

Table Type 3

Table AD

	5.	5.	4.	
2.180	3.930	5.680	7.430	
.400	.875	1.350	1.825	2.300
.500	1.000	1.500	2.000	3.000
.105	0.000	-.105	-.210	-.420
.114	-.000	-.114	-.227	-.455
.068	0.000	-.068	-.137	-.274
.015	0.000	-.015	-.030	-.061
.002	0.000	-.002	-.004	-.009
.036	0.000	-.036	-.071	-.143
.039	0.000	-.039	-.077	-.155
.023	0.000	-.023	-.047	-.093
.005	-.000	-.005	-.010	-.021
.001	0.000	-.001	-.001	-.003
.020	0.000	-.020	-.041	-.081
.022	0.000	-.022	-.044	-.088
.013	-.000	-.013	-.027	-.053
.003	-.000	-.003	-.006	-.012
.000	0.000	-.000	-.001	-.002
.014	0.000	-.014	-.027	-.055
.015	0.000	-.015	-.030	-.059
.009	0.000	-.009	-.019	-.036
.002	0.000	-.002	-.004	-.008
.000	0.000	-.000	-.001	-.001

Table Type 4

Figure 9. Examples of Four Table Types (Concluded)

3.2 ENGINE DATA FILE

The engine data file structure is shown in Figure 10.

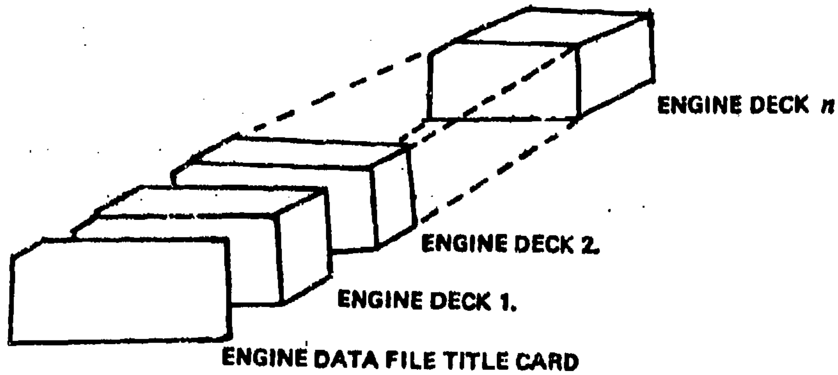


Figure 10. Engine Data File Structure

As can be seen from Figure 10, there may be multiple engine disks on an engine data file., Each deck is processed sequentially during a program execution using the user terminal input given at the beginning of the run. There is only one title card located at the beginning of the engine data file. The structure for an engine deck is shown in Figure 11.

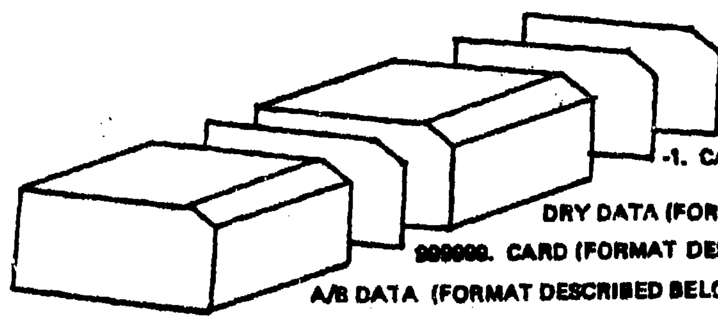


Figure 11. Engine Deck Structure

A data card in the engine deck has the following format:

Cols.		
1-7	Freestream Mach Number	F7.0
8-14	Pressure Altitude (ft)	F7.0
15-21	Power Setting	F7.0
22-28	Net Thrust (lbs)	F7.0
29-35	Fuel Flow (lbs/hr)	F7.0
36-42	Corrected Airflow, $Wa\sqrt{\theta}/\delta$ (lbs/sec)	F7.0
43-49	Nozzle Total Pressure Ratio	F7.0
50-56	Nozzle Throat Area	F7.0
57-63	Nozzle Exit Area	F7.0
64-70	Nozzle Thrust Coefficient	F7.0

3.3 INLET MAP FILE

The inlet map file consists of three separate sections of input

(1) file name
(2) other inlet parameters
(3) tables

The tables can consist of a maximum of 15 maps or a minimum of 2 maps.

The standard form of inlet input data contains 14 data maps plus one additional data map that is added if the user wishes to include a reference recovery schedule that is different from MIL STD 5008B. The short form (2 map) inlet input consists of one inlet recovery map and one inlet total drag map, each as functions of $W\sqrt{\theta}/\delta$ AC and M_0. The short form input can be used any time the inlet data are provided in the specified two-map format. A common way to obtain the two-map format is by converting the 14-map format data into the two-map format by means of the INLTMAP computer program described in AFFDL-TR-72-147-Vol. II.

The file name is an 80 character title which correctly describes the inlet. The other inlet parameter needed for a PIPSI execution are described on 3 cards:

	Description	Format
Card 1	Blank	
Card 2	Blank	
Card 3		
Cols 21-28	Starting Mach number	F7.0

3.3.1 Inlet Maps File (Long)

This inlet map file consists of up to 15 tables. The tables are input in sequential order and are listed below. The inlet map file tables must be preceded by a card specifiying the inlet starting Mach number. This is entered in Cols. 1-7 using an F7.0 format.

Table 1

A Type 1 table of Local Mach Number versus Freestream Mach Number. This table is used to account for the fact that the local flow field ahead of the inlet may be different from free-stream.

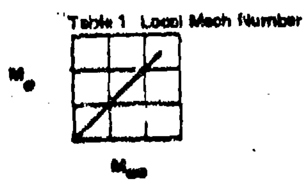


Table 2

A Type 3 table of Recovery versus Mass Flow and Local Mach Number. This table is used to obtain the inlet total pressure recovery as a function of "engine plus bypass" mass flow ratio for each free-stream Mach number.

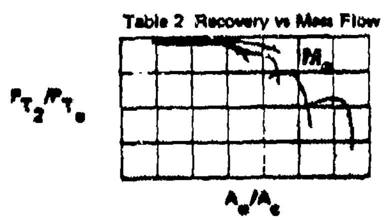


Table 2B

A Type 1 table of Matched Inlet Recovery versus Local Mach Number. This table is used to obtain the "matched" inlet total pressure recovery for sizing purposes and for mixed compression mode inlet operation at free-stream Mach numbers greater than M_{start}.

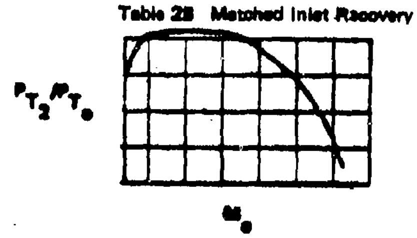


Table 2C

A Type 1 table of Matched Mass Flow versus Local Mach Number. The data in this table are used to obtain the "matched" engine-plus-bypass mass flow ratio for sizing purposes. The data from this table are also used for mixed-compression inlet operation above starting Mach number, M_{start}.

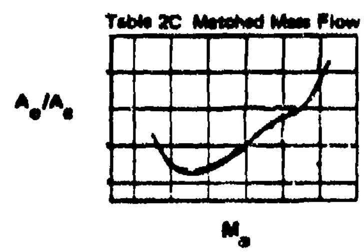


Table 2D

A Type 1 table of Buzz Limit versus Local Mach Number. This table provides a first-order estimate of the minimum inlet mass flow ratio at which buzz is likely to occur.

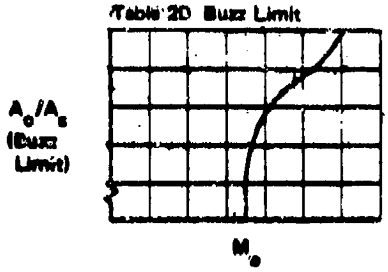


Table 2E

A Type 1 table of Distortion Limit versus Local Mach Number. This table provides a first-order estimate of the maximum inlet mass flow ratio that can be reached before engine distortion limits are likely to be exceeded.

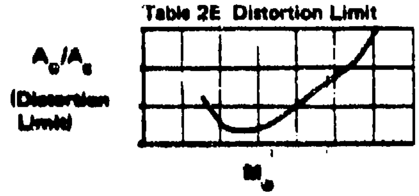


Table 3

A Type 3 table of Spillage Drag versus Inlet Supply ratio and Local Mach Number. This table provides the inlet spillage drag coefficient variation as a function of inlet mass flow ratio and Mach number. The drag coefficient data are "zeroed-out" at a reference mass flow ratio which is presented in Table 3B.

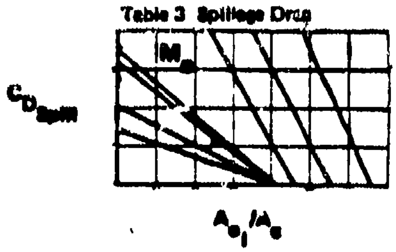


Table 3A

A Type 1 table of Reference Spillage Drag versus Local Mach Number. This table presents the reference spillage drag coefficient as a function of Mach number. This drag coefficient corresponds to the spillage drag of the excess airflow between the reference mass flow ratio and a mass flow ratio of 1.0.

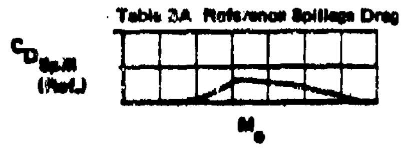


Table 3B

A Type 1 table of Reference Mass Flow versus Local Mach Number. This table specifies the reference mass flow used as a basis for spillage drag calculation. The spillage drag at the reference mass flow ratio is normally included in the aerodynamic drag polar, since it is not throttle-dependent.

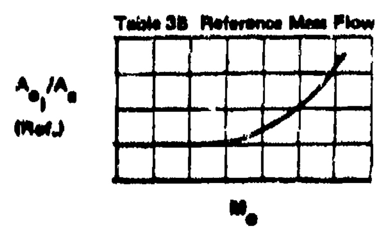


Table 4

A Type 2 table of Boundary Layer Bleed Drag versus Bleed Supply Ratio and Local Mach Number. This table is used to obtain the boundary layer bleed drag coefficient as a function of boundary layer bleed mass flow ratio and Mach number. This table is used during operation in the external-compression mode.

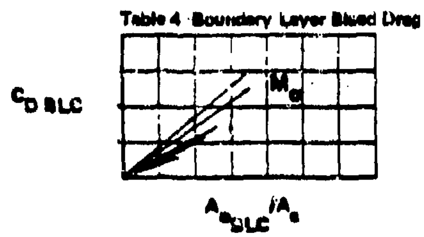


Table 5

A Type 2 table of Bypass Drag versus Bypass Supply Ratio and Local Mach Number. This table is used to obtain the bypass drag coefficient after the amount of bypass mass flow is determined at a given local Mach number.

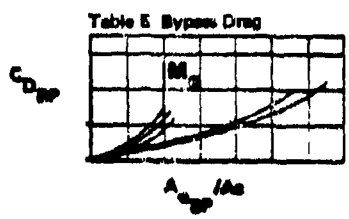


Table 6A

A Type 3 table of Bleed Supply ratio versus A_0/A_c and Local Mach Number. This table supplies the data required to obtain the boundary layer bleed mass flow ratio as a function of "engine-plus-bypass" mass flow ratio for a given local Mach number. It is used in the external-compression operating mode.

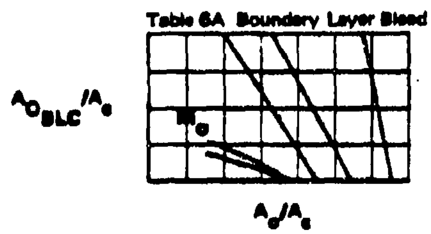


Table 6B

A Type 1 table of Matched Boundary Layer Bleed ratio versus Local Mach Number. This table provides the boundary layer bleed mass flow ratio for mixed-compression mode operation. For mixed-compression operation it is assumed that the bypass will be scheduled to keep the inlet operating at the design shock position.

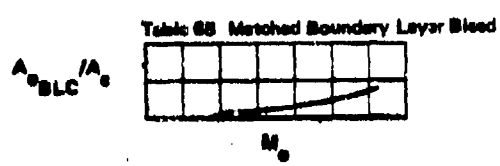


Table 7

A Type 3 table of Bypass Ratio versus Engine Supply ratio and Local Mach Number. This table is used to schedule the amount of bypass mass flow as a function of engine mass flow ratio and local Mach number for external-compression mode operation.

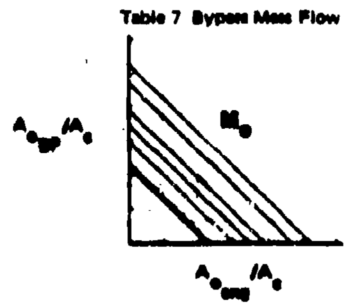
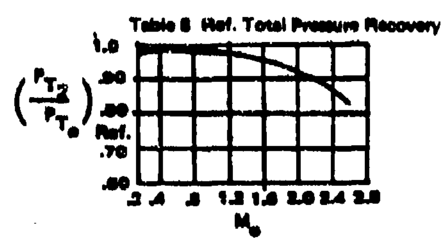


Table 8

This is an optional Type 1 table of reference recovery factor versus Free-stream Mach Number. This input table is used if the uninstalled engine data are based on a total pressure recovery schedule vs. Mach number that is different from MIL STD 5008B. The user can input the new schedule using this one-dimensional table. If the table is not present the program will assume that the uninstalled engine data are based on the MIL STD 5008B recovery schedule.



3.3.2 Inlet Map File (Short)

This inlet map file consists of only two tables. This input data format can be used if the inlet input data are available in the form of two comprehensive maps which include all the individual effects. The two-map format does not provide good visibility of the individual contributors to drag and recovery, but is sometimes preferred by users wishing to know only the total result. This format is not used very often because the two-maps are normally obtained by starting with the 14 maps and converting them to two maps. Therefore, if the 14 maps are already available, there is little reason to convert to the two-map format.

Table RF

A Type 2 table of Recovery versus $\frac{W\sqrt{\theta}}{\delta A_c}$ and Local Mach Number

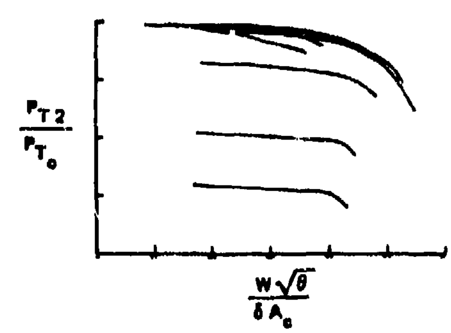
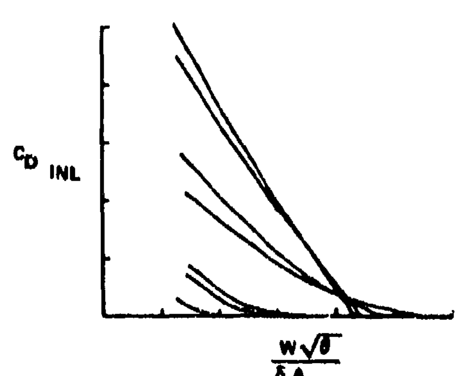


Table CD

A Type 2 table of Inlet Drag versus $\frac{W\sqrt{\theta}}{\delta A_c}$ and Local Mach Number



3.4 AFTERBODY MAP FILE

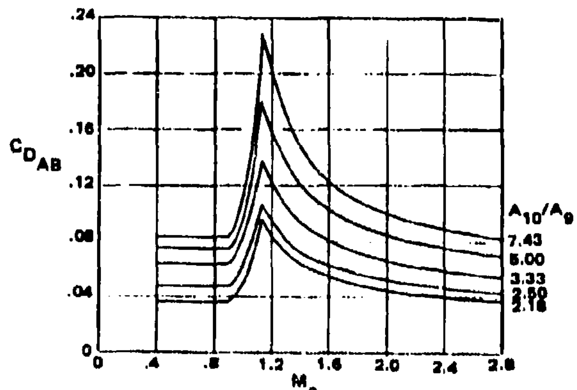
The afterbody file consists of three separate sections of input.

(1) file name
(2) other parameters
(3) tables

The file name is an 80 character title which correctly describes the aft body being simulated. Following this are 4 blank cards or the cards described in Section 4.2.1.2 of the Derivative Procedure Document (Vol. III).

Table AB

The afterbody drag table is a type 2 (non-symmetric) table of afterbody drag versus A10/A9 and local Mach number.



The same table format is used for both round and two-dimensional nozzles; however, the afterbody drag coefficient in the input table for the two-dimensional nozzle is defined differently from that for the round nozzle input. These coefficients are defined as follows:

For Round Nozzle:

$$C_{D\,AB} = \frac{D_{AB}}{q_o A_{10}}$$

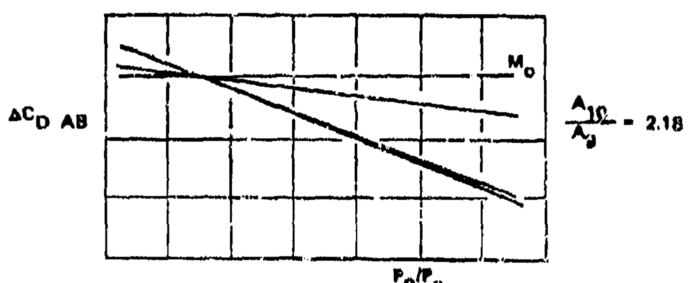
For Two-Dimensional Nozzle: $C_{D\,AB} = \dfrac{D_{AB}}{q_o(A_{10} - A_9)}$

The present version of the input data maps for the two-dimensional nozzle is different from that for the round nozzle because the existing calculation routines were developed using the calculation routines from two different nozzle/aftbody computer routines - one developed for round nozzles and one developed specifically for two-dimensional nozzles. When the present program was developed both these calculation routines were included without change.

The two-dimensional nozzle drag coefficient was originally based on $(A_{10}-A_9)$ rather than A_{10} because it offered a more direct use of the correlated drag data.

Table AD

A type 4 table of afterbody drag correction versus pressure ratio, local Mach number and A_{10}/A_9 ratio. This table is optional and will be defaulted to zero if it is not present in the afterbody file.



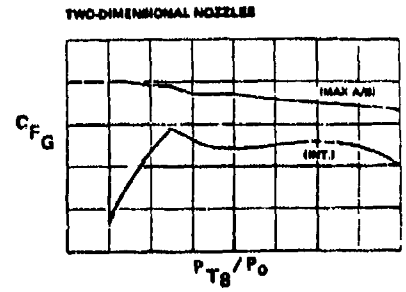
3.5 NOZZLE THRUST COEFFICIENT (C_{F_G}) FILE

This is an optional file and is only needed if the user selects the tabular (C_{F_G} =1) option when inputting data at the terminal. The C_{F_G} file consists of three separate sections of input:

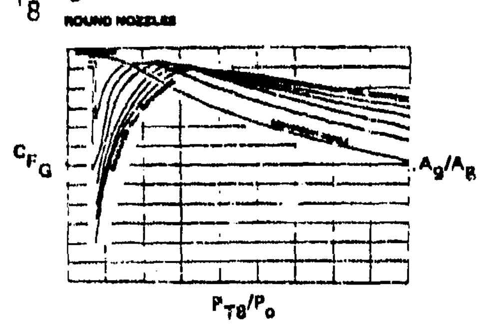
(1) file name
(2) other parameters
(3) table

The file name is an 80 character title which correctly describes the C_{F_G} data. Following this are two blank cards. The format of the table varies, depending on whether the user has selected a round or 2-dimensional nozzle.

For a 2-dimensional nozzle the table is a Type 2 table of nozzle thrust coefficient versus P_{T_8}/P_o and PS.



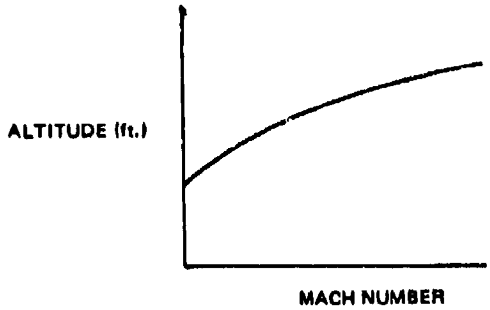
For a Round Nozzle the table is a Type 2 table of nozzle thrust coefficient versus A_9/A_8 and P_{T_8}/P_o.



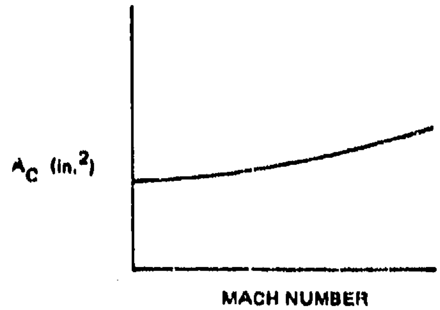
3.6 CAPTURE AREA FILE

This is an optional file which is only needed when the user selects the variable capture area options 2 and 3 (subsection 4.13.2) during a interactive session. The capture area file contains one table which is used to determine a capture area versus Mach number schedule to be used during the program execution.

If the user selects option 2, a Type 1 table of Mach number versus altitude is expected.



If the user selects option 3, a Type 1 table of capture area versus Mach number is expected.



SECTION IV

USER OPTIONS

The PIPSI program is designed to be run interactively. The user must enter data in response to program displayed questions in order to execute the program.

These questions are enumerated as follows:

4.1 NOZZLE THRUST COEFFICIENT FLAG

The user may input either

0\. - for C_{F_G} from engine deck

1\. - for C_{F_G} from C_{F_G} table*

2\. - for $C_{F_G} = 1.$

*NOTE: C_{F_G} file (subsection 3.5) must be attached.

4.2 NOZZLE TYPE FLAG

The user may input either

1\. - for a round nozzle

2\. - for a two-dimensional nozzle

4.3 CAPTURE AREA OPTION FLAG

The user may input either

1\. - for constant capture area option (Must be used if short form inlet map is used)

2\. - for variable capture area option

4.4 ENGINE NUMBER AND SCALE FACTOR

The user must input the number of engines and engine scale factor to be used in subsequent calculations.

4.5 MAXIMUM AND INTERMEDIATE POWER SETTINGS

The user must enter these values in order to determine the correct gamma. (If power setting less than max power setting and greater than intermediate power setting the gamma = 1.3)
(If power setting less than intermediate power setting the gamma = 1.35)

4.6 A10 AND A10A9R

The user must enter the values for the maximum cross-sectional reference area in ft^2 and the reference nozzle exit area ratio.

4.7 REFERENCE MASS FLOW RATIO FLAG

The user may input either

0. - to use Tables 3A and 3B in spillage drag calculation
1. - use mass flow ratio of 1. in spillage drag calculation

4.8 ENGINE PRINT OPTION

The user may input either

1. - to not print the engine input data on TAPE6
2. - to have the engine input data listed on TAPE6

4.9 INLET BYPASS MODE

The user may input any of the following:

1. - to have all excess inlet airflow spilled externally
2. - to have all excess inlet airflow bypassed above an input Mach number (MOSBP)
3. - use scheduled bypass with rest of excess inlet airflow spilled (table 7)

4. - determine the optimum combination of bypass and spillage for a minimum inlet drag
5. determine the optimum combination of bypass and spillage for a minimum SFCA

4.10 ENTER MOSBP FOR START OF BYPASS

This prompt will only appear if the user has specified an inlet bypass mode = 2. In this case the user must enter a Mach number for start of bypass.

4.11 ENTER BYPASS PRINT OPTION

The user may enter either

0. - for no bypass printout
1. - to obtain bypass mode printout for bypass modes 4 or 5

4.12 ENTER RECOVERY AND DRAG MAPS FLAG*

The user may enter either

0. - to use the standard 15 inlet maps
1. - to use only 2 maps for the inlet

*NOTE: User should read section 3.3 for inlet map file structure.

4.13 CAPTURE AREA DETERMINATION OPTION

The program will now prompt the user as to the method by which the capture area is to be determined.

4.13.1 Constant Capture Area Options

If the user has selected the constant capture area option described in Section 2.3, the user must respond with either

1. - for the sizing envelope option
2. - for the sizing point option
3. - for input of a single capture area (must be used if short form inlet input is used)

For the sizing envelope option the user will be asked to input the low and high Mach numbers to be used for capture area sizing. The engine deck will be searched for all data cards with Mach numbers between these bounds. The maximum capture area for the cards in these bounds is the capture area to be used in subsequent calculations.

For the sizing point option the user will be asked to input a design Mach number and a design altitude. The engine deck will be searched until this combination is found on a data card and the capture area from this card is used in subsequent calculations. The program will not interpolate for this point so it must be in the engine deck input.

In option 3, the user simply inputs the capture area to be used.

4.13.2 Variable Capture Area Options

If the user selected the variable capture area option described in Section 3.6, then the user must respond with either

1. - for sizing envelope option
2. - for Mach number versus altitude schedule
3. - for Mach number versus capture area schedule

For the sizing envelope option the user will be asked to input the low and high Mach numbers to be used for determining a capture area versus Mach number schedule. The engine deck will be searched for all data cards with unique Mach numbers between these Mach number bounds. A schedule of capture area versus Mach number is developed from these cards.

If option 2 was selected, the user will be asked if the Mach altitude schedule is to input from terminal or input from the capture area file. The user must enter one of the following:

0. - if the schedule is to be input from the terminal
1. - if the schedule is from the capture area file

If the schedule is from the terminal, the data is input in the form (number of pairs followed by the pairs of Mach number - altitude values) all separated by blank spaces.

If option 3 was selected, the user will be asked if the capture area versus Mach number schedule is to be input from the terminal or input from the capture area file. The user must enter one of the following:

0. - if the schedule is to be input from the terminal
1. - if the schedule is from the capture area file

If the schedule is from the terminal the data is input in the form (number of pairs followed by the pairs of Mach number - capture area values) all separated by blank spaces.

4.14 CORRECTION DESIRED

After all these inputs have been entered, they will be displayed on the terminal for the user to peruse. The user will be asked to enter a correction desired flag. The user must respond with either

0. - no correction desired, which begins the processing of the engine decks
1. - change the variable that is incorrect. The user will then be asked the name of the incorrect variable and will be given the opportunity to correct it.

4.15 DATA FORMAT

If during a terminal session the user responds with an input which is in an incorrect format, an error message will appear on the terminal and the user will be asked to re-enter the data. If the user wishes to exit the program during the question and answer sequence a %A is entered in response to the input prompt.

When the engine deck has been processed, the first prompt will again be displayed to begin the next engine deck. At this point a normal exit can be accomplished by entering "END".

SECTION V

PROGRAM EXECUTION SEQUENCE

In order to execute PIPSI, all data files and the PIPSI program must be attached. The appropriate data files <u>must</u> be attached to specific file names recognized by the program. These are -

<u>File name used in Program</u>

TAPE51 = inlet map file

TAPE52 = afterbody map file

TAPE53 = C_{F_G} file

TAPE54 = Capture area file

TAPE1 = Engine data file

A typical CDC system set of control cards is shown in Figure 12. All of the program results not displayed on the terminal are placed on a file called TAPE6. This file may be saved or printed by the user utilizing the appropriate control statements. In Figure 12 output was disposed to the line printer. Examples of typical input data files are presented in Section VI.

```
ATTACH, TAPE51 = ATS2PM.  ]
ATTACH, TAPE52 = ATS2DM.  ]
ATTACH, TAPE53 = CV2DM.   }  Attach necessary data files
ATTACH, TAPE54 = MARY3M.  ]
ATTACH, TAPE1  = AFE.     ]

ATTACH, LGO    = PIPSI.   }  Attach PIPSI relocatable
                             binary
PIPSI.                    }  Execute program

REWIND, TAPE6.            }  Output results to line
COPYBF, TAPE6, OUTPUT        printer
```

Figure 12. Typical Set of Control Cards

SECTION VI

EXAMPLES OF TABULAR DATA

6.1 INLET TABLES (LONG FORM)

```
ATS2 INLET MAP
   .95     .70    7.30    2.50     .03     .20   17.50    1.00   15.00    2.00
   .10    1.00   15.00    2.00     .20    0.00    0.00     .12    0.00
  1.00    1.25    3.00     .75    1.00
TABLE1      3.
 0.000    .200   2.500
 0.000    .200   2.500
TABLE2A     6.
 7.000   6.000   7.000   7.000   8.000   9.000
  .550    .700    .850   1.300   1.900   2.500
  .559    .639    .719    .700    .843    .859    .879
  .990    .990    .994    .968    .949    .932    .874
  .480    .560    .639    .719    .759    .775
  .989    .989    .984    .973    .944    .909
  .399    .470    .559    .639    .679    .700    .724
  .988    .988    .987    .981    .973    .960    .898
  .416    .500    .584    .669    .710    .732    .755
  .960    .959    .957    .953    .947    .935    .880
  .453    .545    .637    .730    .776    .800    .800    .914
  .938    .932    .927    .920    .917    .902    .887    .862
  .493    .594    .694    .794    .896    .926    .932    .940    .947
  .808    .803    .889    .884    .875    .865    .860    .840    .790
TABLE2B     9.
 0.000    .200    .400    .600    .900   1.000   1.300   1.900   2.500
  .692    .849    .963    .971    .975    .969    .947    .910    .865
TABLE2C     7.
  .400    .600    .800   1.000   1.300   1.900   2.500
 1.046    .774    .630    .664    .702    .798    .915
TABLE2D     6.
 0.000   1.500   1.600   1.900   2.700   2.900
 0.000   0.000    .755    .755    .834    .834
TABLE2E     6.
  .550    .700    .930   1.300   1.900   2.500
  .282    .480    .399    .416    .458    .493
TABLE3      9.
 3.000   3.000   7.000   9.000   9.000   9.000   7.000   7.000   7.000
 0.000    .549    .550    .700    .950   1.300   1.600   1.900   2.500
 0.000    .798   1.000
 0.000   0.000   0.000
 0.000    .798   1.000
 0.000   0.000   0.000
  .240    .320    .909    .479    .959    .572   1.000
  .157    .096    .048    .011    .002   0.000   0.000
  .240    .320    .400    .480    .563    .659    .719    .759   1.000
  .255    .171    .103    .053    .028    .014    .003   0.000   0.000
  .240    .320    .430    .480    .560    .640    .770    .770   1.000
  .336    .231    .145    .082    .043    .073    .009   0.000   0.000
  .252    .335    .419    .503    .987    .671    .755    .804   1.000
  .442    .320    .214    .135    .078    .035    .015   0.000   0.000
  .264    .439    .615    .705    .779    .798   1.000
  .764    .456    .725    .170    .025   0.000   0.000
  .459    .581    .643    .734    .940    .852   1.000
  .766    .593    .402    .230    .023   0.000   0.000
  .500    .609    .799    .899    .956    .961   1.000
  .925    .535    .333    .132    .010   0.000   0.000
```

TABLE3A	3.						
0.000	1.000	2.500					
0.000	0.000	0.000					
TABLE3B	3.						
0.000	1.600	2.400					
.999	.999	.999					
TABLE4	5.	6.					
0.000	.849	.850	1.300	2.050	2.500		
0.000	.011	.022	.044	.066			
0.000	0.000	0.000	0.000	0.000			
0.000	0.000	0.000	0.000	0.000			
0.000	.007	.014	.028	.042			
0.000	.010	.021	.042	.062			
0.000	.011	.022	.044	.066			
0.000	.011	.023	.046	.068			
TABLE5	7.	8.					
0.000	.849	.850	1.000	1.300	1.600	2.050	2.800
0.000	.042	.083	.125	.166	.208	.249	
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
0.000	.062	.125	.198	.280	.380	.500	
0.000	.050	.100	.156	.217	.290	.375	
0.000	.036	.075	.117	.161	.217	.285	
0.000	.030	.062	.096	.133	.181	.234	
0.000	.026	.055	.084	.120	.164	.220	
0.000	.023	.051	.083	.123	.170	.233	
TABLE6A	8.						
2.000	2.000	5.000	5.000	5.000	6.000	6.000	6.000
0.000	.800	1.030	1.300	1.600	1.900	2.200	2.500
-.000	.797						
0.000	0.000						
-.001	.800						
0.000	0.000						
.486	.567	.674	.791	.812			
.009	.008	.005	.003	0.000			
.500	.584	.702	.753	.838			
.015	.014	.011	.009	0.000			
.572	.611	.751	.788	.877			
.024	.022	.015	.013	0.000			
.545	.637	.730	.805	.851	.917		
.033	.032	.028	.022	.015	0.000		
.570	.666	.742	.865	.880	.958		
.048	.046	.041	.027	.023	0.000		
.594	.694	.794	.894	.926	.999		
.066	.061	.055	.041	.033	0.000		
TABLE6B	5.						
0.000	.800	1.300	1.900	2.900			
0.000	0.000	.011	.022	.033			
TABLE7	6.						
2.000	2.000	4.000	4.000	4.000	4.000		
0.000	1.599	1.600	1.900	2.200	2.900		
0.000	1.000						
0.000	0.000						
0.000	1.000						
0.000	0.000						
.350	.749	.752	1.000				
.404	.004	0.000	0.000				
.366	.798	.807	1.000				
.442	.009	0.000	0.000				
.383	.855	.869	1.000				
.485	.013	0.000	0.000				
.400	.915	.930	1.000				
.532	.015	0.000	0.000				

6.2 INLET TABLES (SHORT FORM)

TABLERF10.		10.							
.5	.75	1.0	1.25	1.5	1.75	2.0	.25	.5	.5
3.63	7.26	10.89	14.52	18.15	21.78	25.41	29.04	30.83	32.67
.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685
.99	.99	.99	.99	.99	.99	.99	.99	.99	.9891
.9875	.9872	.9869	.9866	.9863	.986	.9857	.9854	.9851	.9846
.9853	.9851	.9839	.9827	.9815	.9803	.9791	.9779	.9770	.9761
.9425	.9427	.9429	.9432	.9434	.9436	.9439	.9441	.9442	.9443
.9262	.9262	.9263	.9263	.9264	.9265	.9265	.9266	.9266	.9266
.9219	.9223	.9228	.9232	.9237	.9241	.9246	.9245	.8858	.8419
.9538	.9538	.9538	.9536	.9538	.9538	.9538	.9538	.9538	.9538
.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685
.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685	.9685
TABLECD10.		10.							
.5	.75	1.	1.25	1.5	1.75	2.0	.25	.5	.5
3.63	7.25	10.89	14.52	18.15	21.78	25.41	29.04	30.85	32.67
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
.5928	.5063	.4198	.3333	.2467	.1735	.1133	.0675	.0536	.0399
.7475	.6505	.5535	.4567	.3598	.2732	.1974	.1377	.1143	.0946
.8769	.7682	.6598	.5517	.4438	.3467	.2650	.1968	.1684	.1401
1.065	.9508	.8366	.7223	.608	.4936	.3791	.2646	.2118	.1691
1.075	.9427	.8103	.6779	.5456	.4132	.2807	.1683	.1303	.0976
1.0776	.9154	.7531	.5906	.428	.2652	.1321	.0557	.0444	.0404
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

6.3 NOZZLE/AFTBODY DRAG TABLES


```
CD2R INPUT MAP
   1.00    2.00    0.00     .17     .10                          } AFTBODY DERIVATIVE PARAMETERS
   0.00
   7.00    7.00    7.00    7.00    7.00
 637.00  700.00  760.00  800.00  820.00  830.00  876.00
  44.50   41.50   35.00   31.00   25.00   20.50   20.50
 637.00  700.00  760.00  800.00  820.00  830.00  876.00
  44.50   41.50   35.00   31.00   25.00   20.50   17.84
 637.00  700.00  760.00  800.00  820.00  830.00  876.00          NOZZLE/AFTBODY AREA
  44.50   41.50   35.00   31.00   25.00   20.50   13.39          DISTRIBUTION DATA
 637.00  700.00  760.00  800.00  820.00  830.00  876.00
  44.50   41.50   35.00   31.00   25.00   20.50    8.92
 637.00  700.00  760.00  800.00  820.00  830.00  876.00
  44.50   41.50   35.00   31.00   25.00   20.50    6.00
   0.00    2.00    1.00                                          } CONSTANT PARAMETERS
TABLEAB      8.      5.
  2.180   2.500   3.330   5.000   7.430
   .400    .900   1.130   1.200   1.400   1.600   2.000   2.300
   .096    .097    .156    .135    .103    .086    .068    .061  BASIC DRAG
   .107    .108    .167    .145    .110    .094    .076    .067  MAP DATA
   .123    .124    .198    .173    .132    .112    .089    .079  FOR
   .134    .135    .240    .209    .159    .134    .108    .096  Pe/Po = 1.0
   .142    .143    .288    .251    .186    .153    .123    .109
TABLEAD      5.      5.      4.
  2.180   3.930   5.690   7.430
   .400    .875   1.350   1.825   2.300
   .500   1.000   1.500   2.000   3.000
   .105   0.000   -.105   -.210   -.420
   .114   -.000   -.114   -.227   -.455
   .068   0.000   -.068   -.137   -.274
   .015   0.000   -.015   -.030   -.061
   .002   0.000   -.002   -.004   -.009                          OPTIONAL DRAG CORRECTION
   .036   0.000   -.036   -.071   -.143                          DATA FOR EFFECTS OF
   .039   0.000   -.039   -.077   -.155                          NOZZLE EXIT STATIC
   .023   0.000   -.023   -.047   -.093                          PRESSURE ≠ 1.0
   .005   -.000   -.005   -.010   -.021
   .001   0.000   -.001   -.001   -.003
   .020   0.000   -.020   -.041   -.081
   .022   0.000   -.022   -.044   -.088
   .013   -.000   -.013   -.027   -.053
   .003   -.000   -.003   -.006   -.012
   .000   0.000   -.000   -.001   -.002
   .014   0.000   -.014   -.027   -.055
   .015   0.000   -.015   -.030   -.059
   .009   0.000   -.009   -.018   -.036
   .002   0.000   -.002   -.004   -.008
   .000   0.000   -.000   -.001   -.001
```

6.4 NOZZLE GROSS THRUST COEFFICIENT TABLE

```
CV1 INPUT MAP
0.        0.        C.        11.45
0.        1.        0.
TABLECV10.          7.
1.        1.1       1.2       1.3       1.4       1.5       1.6
1.5       2.0       3.0       4.0       5.0       6.0       8.0       10.       14.       18.
.992      .992      .986      .976      .966      .955      .938      .924      .903      .866
.932      .965      .984      .986      .962      .975      .960      .947      .925      .908
.888      .935      .977      .986      .988      .983      .970      .958      .938      .92
.862      .905      .965      .982      .986      .982      .972      .964      .947      .932
.840      .89       .942      .970      .983      .966      .976      .968      .954      .942
.822      .876      .932      .962      .977      .982      .976      .970      .959      .946
.9        .867      .922      .952      .97       .979      .978      .972      .961      .952
```

6.5 INLET CAPTURE AREA TABLE (OPTIONAL)

```
TABLECM5.
.8       .95      1.2      1.6      2.0
4.740    4.719    4.802    5.502    6.361
```

6.6 ENGINE DATA TABLE

AIR FORCE TEST CASE

0.00	0.	1.00	18326.	36482.	182.69	2.767	3.753	3.842	.9856
.20	0.	1.00	19225.	39433.	182.68	2.982	3.752	3.962	.9859
.50	0.	1.00	21390.	45309.	182.69	3.471	3.704	4.184	.9865
.85	0.	1.00	24134.	53700.	167.86	4.129	[illegible]	4.576	.9863
1.00	0.	1.00	25337.	58386.	158.66	4.491	3.726	4.994	.9860
1.20	0.	1.00	28031.	66436.	146.70	5.121	3.738	5.498	.9854
1.60	0.	1.00	35537.	86437.	121.41	6.624	3.807	6.608	.9840
1.78	0.	1.00	40482.	94250.	112.92	7.613	3.830	6.960	.9845
1.95	0.	1.00	46598.	114685.	106.69	8.846	3.835	7.272	.9849
2.12	0.	1.00	53272.	132392.	101.03	10.285	3.837	7.315	.9827
2.30	0.	1.00	60994.	153687.	95.80	12.063	3.831	8.064	.9814
0.00	10000.	1.00	12973.	25956.	182.68	2.762	3.863	3.963	.9856
.20	10000.	1.00	13623.	28054.	182.68	2.971	3.869	4.091	.9859
.50	10000.	1.00	15202.	32239.	182.69	3.456	3.822	4.822	.9865
.85	10000.	1.00	19544.	41635.	181.25	4.625	3.700	4.825	.9868
1.00	10000.	1.00	20659.	45137.	171.72	5.040	3.712	5.146	.9867
1.20	10000.	1.00	22776.	51088.	157.96	5.716	3.724	6.066	.9829
1.60	10000.	4.00	29635.	67608.	132.73	7.604	3.750	6.813	.9845
1.60	10000.	4.00	21277.	38290.	132.73	7.735	3.096	6.219	.9785
1.60	10000.	4.00	12842.	19181.	132.73	7.842	2.484	4.816	.9786
1.78	10000.	4.00	32293.	75385.	120.07	8.388	3.814	6.995	.9850
1.78	10000.	4.00	22992.	42696.	120.07	8.538	3.157	6.352	.9817
1.78	10000.	4.00	12629.	19625.	120.07	8.668	2.485	5.242	.9769
1.95	10000.	4.00	36560.	86206.	112.36	9.597	3.837	7.475	.9840
1.95	10000.	4.00	25833.	49823.	112.36	9.768	3.185	6.639	.9823
1.95	10000.	4.00	13325.	21278.	112.36	9.924	2.487	5.410	.9797
2.12	10000.	4.00	41561.	99632.	105.87	11.123	3.831	7.983	.9821
2.12	10000.	4.00	29210.	56087.	105.87	11.318	3.190	7.119	.9815
2.12	10000.	4.00	14273.	23424.	105.87	11.501	2.481	5.982	.9782
2.30	10000.	4.00	47345.	114606.	100.10	12.954	3.637	8.216	.9804
2.30	10000.	4.00	33025.	64907.	100.10	13.178	3.208	7.191	.9819
2.30	10000.	4.00	15111.	25769.	100.10	13.396	2.484	6.072	.9810
0.00	22500.	1.00	8107.	16323.	182.68	2.755	4.014	4.131	.9856
.20	22500.	1.00	8533.	17646.	182.68	2.961	4.025	4.268	.9859
.50	22500.	1.00	9557.	20285.	182.68	3.449	3.981	4.530	.9864
.85	22500.	1.00	12513.	26303.	182.68	4.665	3.839	5.044	.9868
1.00	22500.	1.00	14473.	30346.	182.68	5.527	3.755	5.393	.9870
1.20	22500.	1.00	17143.	35920.	175.51	6.669	3.706	6.386	.9846
1.60	22500.	4.00	21945.	47096.	146.17	8.776	3.736	7.090	.9849
1.60	22500.	4.00	15970.	26673.	146.17	8.929	3.075	6.190	.9827
1.60	22500.	4.00	10157.	13940.	146.17	9.047	2.484	5.159	.9795
1.78	22500.	4.00	24630.	53538.	134.49	10.517	3.743	7.394	.9837
1.78	22500.	4.00	17785.	30321.	134.49	10.190	3.090	6.532	.9823
1.78	22500.	4.00	10860.	15320.	134.49	10.329	2.482	5.515	.9797
1.95	22500.	4.00	26839.	59583.	122.63	11.062	3.795	7.915	.9821
1.95	22500.	4.00	14228.	33745.	122.63	11.237	3.140	7.169	.9805
1.95	22500.	4.00	10916.	15905.	122.63	11.424	2.485	5.713	.9803
2.12	22500.	4.00	29656.	67119.	113.50	12.418	3.833	8.056	.9816
2.12	22500.	4.00	21099.	38013.	113.50	12.639	3.180	7.238	.9815
2.12	22500.	4.00	11152.	16743.	113.50	12.840	2.485	6.059	.9804
2.30	22500.	4.00	33535.	77237.	106.70	14.386	3.835	8.298	.9784
2.30	22500.	4.00	28674.	43743.	106.70	14.639	3.194	7.582	.9798
2.30	22500.	4.00	11818.	18405.	106.70	14.877	2.484	6.274	.9806
0.00	35000.	1.00	4788.	9743.	182.68	2.757	4.146	4.284	.9856
.20	35000.	1.00	5061.	10538.	182.68	2.963	4.166	4.436	.9859
.50	35000.	1.00	5706.	12123.	182.68	3.441	4.140	4.725	.9864
.85	35000.	1.00	7527.	15740.	182.68	4.657	4.005	5.275	.9869
1.00	35000.	1.00	8733.	18164.	182.68	5.518	3.921	5.746	.9868
1.20	35000.	1.00	11041.	22449.	182.68	7.081	3.797	6.815	.9837
1.60	35000.	4.00	15500.	31618.	162.97	10.321	3.717	7.543	.9830

1.60	35000.	4.00	11474.	17907.	162.97	10.501	3.051	6.156	.9845
1.60	35000.	4.00	7667.	9789.	162.97	10.634	2.484	5.355	.9821
1.78	35000.	4.00	17419.	35821.	149.53	11.713	3.731	7.736	.9819
1.78	35000.	4.00	12741.	20288.	149.53	11.917	3.070	7.006	.9815
1.78	35000.	4.00	8181.	10721.	149.50	12.074	2.484	5.634	.9819
1.95	35000.	4.00	19375.	40433.	138.00	13.255	3.743	8.383	.9803
1.95	35000.	4.00	14066.	22899.	138.00	13.484	3.087	7.105	.9815
1.95	35000.	4.00	6726.	11718.	138.00	13.667	2.484	6.025	.9815
2.12	35000.	4.00	21239.	45227.	126.74	14.827	3.765	8.263	.9779
2.12	35000.	4.00	15307.	25614.	126.74	15.084	3.114	7.497	.9797
2.12	35000.	4.00	9036.	12510.	126.74	15.298	2.484	6.060	.9822
2.30	35000.	4.00	22899.	50176.	115.17	16.273	3.830	8.673	.9755
2.30	35000.	4.00	16360.	28417.	115.17	16.563	3.177	7.745	.9785
2.30	35000.	4.00	8819.	12682.	115.17	16.825	2.486	6.423	.9805
0.00	47500.	1.00	2566.	5306.	182.68	2.857	3.872	4.025	.9857
.20	47500.	1.00	2719.	5746.	182.68	3.066	3.914	4.197	.9860
.50	47500.	1.00	3080.	6620.	182.68	3.545	3.939	4.516	.9865
.85	47500.	1.00	4108.	8614.	182.68	4.770	3.881	5.161	.9869
1.00	47500.	1.00	4783.	9950.	182.68	5.623	3.831	5.648	.9867
1.20	47500.	1.00	6069.	12313.	182.68	7.206	3.731	6.697	.9841
1.60	47500.	4.00	8174.	16749.	157.43	9.947	3.720	7.312	.9839
1.60	47500.	4.00	6015.	9486.	157.43	10.121	3.056	6.467	.9822
1.60	47500.	4.00	3986.	5174.	157.43	10.250	2.485	5.327	.9816
1.78	47500.	4.00	9207.	19101.	145.25	11.366	3.733	7.334	.9821
1.78	47500.	4.00	6732.	10018.	145.25	11.563	3.074	6.034	.9820
1.78	47500.	4.00	4299.	5712.	145.25	11.716	2.484	5.642	.9814
1.95	47500.	4.00	10295.	21648.	134.56	12.914	3.744	8.015	.9807
1.95	47500.	4.00	7480.	12261.	134.56	13.137	3.092	7.111	.9816
1.95	47500.	4.00	4595.	6270.	134.56	13.315	2.485	5.563	.9830
2.12	47500.	4.00	11413.	24426.	124.60	14.595	3.760	8.260	.9783
2.12	47500.	4.00	8237.	13834.	124.60	14.846	3.114	7.439	.9800
2.12	47500.	4.00	4863.	6789.	124.60	15.057	2.485	6.265	.9808
2.30	47500.	4.00	12290.	27084.	113.16	15.979	3.832	8.629	.9759
2.30	47500.	4.00	8796.	15339.	113.16	16.263	3.162	7.726	.9787
2.30	47500.	4.00	4711.	6839.	113.16	16.522	2.487	6.349	.9806
0.00	60000.	1.00	1317.	2076.	182.68	3.040	3.364	3.530	.9860
.20	60000.	1.00	1386.	3109.	182.68	3.253	3.412	3.696	.9863
.50	60000.	1.00	1591.	3574.	182.68	3.743	3.516	4.034	.9867
.85	60000.	1.00	2159.	4660.	182.68	4.980	3.583	4.833	.9866
1.00	60000.	1.00	2404.	5214.	177.07	5.591	3.611	5.193	.9869
1.20	60000.	1.00	2804.	6069.	166.87	6.512	3.656	6.311	.9839
1.60	60000.	4.00	3898.	8325.	144.42	8.959	3.725	7.088	.9849
1.60	60000.	4.00	2855.	4715.	144.42	9.114	3.067	6.218	.9827
1.60	60000.	4.00	1850.	2526.	144.42	9.232	2.487	5.293	.9789
1.78	60000.	4.00	4492.	9618.	134.73	10.391	3.740	7.637	.9828
1.78	60000.	4.00	3269.	5447.	134.73	10.570	3.086	6.256	.9843
1.78	60000.	4.00	2043.	2834.	134.73	10.713	2.485	5.515	.9806
1.95	60000.	4.00	5112.	11023.	126.07	11.946	3.754	7.830	.9817
1.95	60000.	4.00	3704.	6243.	126.07	12.152	3.105	6.871	.9823
1.95	60000.	4.00	2230.	3149.	126.07	12.321	2.486	5.999	.9800
2.12	60000.	4.00	5782.	12609.	118.27	13.686	3.774	8.187	.9795
2.12	60000.	4.00	4156.	7141.	118.27	13.922	3.130	7.101	.9817
2.12	60000.	4.00	2395.	3451.	118.27	14.125	2.486	6.059	.9817
2.30	60000.	4.00	6286.	14093.	108.13	15.110	3.842	8.511	.9771
2.30	60000.	4.00	4695.	7982.	108.13	15.386	3.196	7.678	.9793
2.30	60000.	4.00	2345.	3513.	108.13	15.636	2.488	6.292	.9809
999999.									
.25	0.	5.00	12051.	11254.	182.68	3.151	2.416	2.481	.9862
.25	0.	6.67	6282.	5690.	135.51	2.144	2.416	2.135	.9841
.25	0.	8.34	2217.	2384.	90.17	1.415	2.416	1.992	.9850
.25	0.	10.00	713.	1344.	55.70	1.163	2.415	1.936	.9850

.50	0.	5.00	12719.	13116.	[illegible]	3.582	2.415	2.631	.9867
.50	0.	6.67	7105.	7238.	141.68	2.549	2.416	2.262	.9853
.50	0.	8.34	2924.	3372.	104.15	1.729	2.415	2.050	.9850
.50	0.	10.00	839.	1698.	74.72	1.321	2.416	1.972	.9850
.80	0.	5.00	13017.	14878.	170.74	4.148	2.416	2.750	.9862
.80	0.	6.67	7592.	8832.	137.64	3.072	2.415	2.474	.9860
.80	0.	8.34	3586.	4740.	109.02	2.244	2.416	2.175	.9844
.80	0.	10.00	1366.	2444.	87.25	1.682	2.417	2.044	.9850
.90	0.	5.00	12937.	15467.	164.82	4.372	2.416	3.124	.9830
.90	0.	6.67	7589.	9472.	135.14	3.298	2.415	2.640	.9854
.90	0.	8.34	3579.	5324.	109.58	2.472	2.415	2.338	.9831
.90	0.	10.00	900.	2852.	89.72	1.881	2.416	2.119	.9804
1.00	0.	5.00	12256.	16130.	158.66	4.632	2.416	3.381	.9808
1.00	0.	6.67	6703.	9969.	131.27	3.519	2.416	2.894	.9799
1.00	0.	8.34	2666.	5748.	108.34	2.681	2.415	2.532	.9795
1.00	0.	10.00	-98.	3150.	89.95	2.072	2.416	2.292	.9789
.25	20000.	5.00	5555.	4804.	182.68	3.154	2.416	2.476	.9862
.25	20000.	6.67	2910.	2481.	135.35	2.150	2.416	2.135	.9841
.25	20000.	8.34	1034.	1127.	89.79	1.419	2.416	1.994	.9830
.25	20000.	10.00	354.	713.	58.75	1.171	2.416	1.938	.9650
.50	20000.	5.00	5862.	5582.	182.68	3.596	2.415	2.623	.9867
.50	20000.	6.67	3271.	3116.	141.24	2.548	2.416	2.258	.9853
.50	20000.	8.34	1352.	1521.	103.67	1.730	2.417	2.053	.9850
.50	20000.	10.00	406.	869.	74.39	1.326	2.416	1.976	.9850
.80	20000.	5.00	7036.	7456.	182.68	4.590	2.415	2.950	.9853
.80	20000.	6.67	4081.	4355.	145.73	3.324	2.416	2.559	.9863
.80	20000.	8.34	1848.	2251.	111.86	2.332	2.416	2.202	.9647
.80	20000.	10.00	513.	1166.	86.88	1.687	2.418	2.047	.9850
.90	20000.	5.00	7658.	8424.	182.68	5.095	2.415	3.258	.9852
.90	20000.	6.67	4432.	4985.	146.95	3.710	2.416	2.743	[illegible]
.90	20000.	8.34	1968.	2607.	114.03	2.614	2.417	2.393	.9835
.90	20000.	10.00	433.	1327.	89.29	1.883	2.417	2.121	.9809
1.00	20000.	5.00	8160.	9617.	182.68	5.704	2.416	3.630	.9831
1.00	20000.	6.67	4490.	5646.	146.74	4.134	2.416	3.272	[illegible]
1.00	20000.	8.34	1692.	2918.	114.17	2.990	2.416	2.589	.9614
1.00	20000.	10.00	-28.	1448.	89.49	2.071	2.416	2.231	.9789
.25	30000.	5.00	3613.	3020.	182.68	3.165	2.416	2.477	.9863
.25	30000.	6.67	2161.	1790.	143.13	2.217	2.415	2.173	.9847
.25	30000.	8.34	1024.	976.	105.54	1.624	2.416	2.033	.9850
.25	30000.	10.00	386.	608.	70.87	1.259	2.418	1.960	.9850
.50	30000.	5.00	3808.	3496.	182.68	3.594	2.416	[illegible]	.9807
.50	30000.	6.67	2370.	2181.	147.62	2.707	2.416	[illegible]	.9856
.50	30000.	8.34	1212.	1242.	114.22	1.957	2.416	[illegible]	.9832
.50	30000.	10.00	471.	745.	85.21	1.461	2.415	2.002	.9850
.80	30000.	5.00	4565.	4645.	182.68	4.399	2.415	2.945	.9853
.80	30000.	6.67	2717.	2956.	151.16	3.507	2.416	2.594	.9866
.80	30000.	8.34	1561.	1745.	120.42	2.587	2.415	2.285	.9853
.80	30000.	10.00	627.	1003.	95.55	1.910	2.416	2.082	.9829
.90	30000.	5.00	4967.	5239.	182.68	5.103	2.415	3.260	.9852
.90	30000.	6.67	3141.	3377.	151.76	3.895	2.416	2.808	.9852
.90	30000.	8.34	1649.	1982.	121.76	2.872	2.416	2.502	.9839
.90	30000.	10.00	405.	1123.	97.18	2.125	2.415	2.209	.9816
1.00	30000.	5.00	5294.	5973.	182.68	5.715	2.415	3.620	.9832
1.00	30000.	6.67	3211.	3816.	151.43	4.340	2.416	3.303	.9790
1.00	30000.	8.34	1504.	2208.	121.61	3.172	2.416	2.685	.9824
1.00	30000.	10.00	336.	1225.	97.28	2.336	2.416	2.344	.9797
.25	45000.	5.00	1827.	1564.	182.65	3.231	2.415	2.499	.9863
.25	45000.	6.67	1104.	962.	142.70	2.371	2.416	2.175	.9846
.25	45000.	8.34	541.	563.	104.68	1.665	2.416	2.042	.9850
.25	45000.	10.00	228.	360.	71.34	1.299	2.417	1.969	.9850
.50	45000.	5.00	1928.	1797.	182.68	3.666	2.416	2.646	.9868

.50	45000.	6.67	1209.	1146.	147.22	2.763	2.415	2.333	.9857
.50	45000.	8.34	633.	695.	113.15	2.003	2.416	2.094	.9834
.50	45000.	10.00	272.	439.	84.72	1.504	2.416	2.010	.9850
.80	45000.	5.00	2305.	2397.	182.68	4.676	2.416	2.969	.9853
.80	45000.	6.67	1481.	1538.	150.76	3.565	2.415	2.606	.9867
.80	45000.	8.34	806.	927.	119.63	2.630	2.416	2.301	.9[illegible]54
.80	45000.	10.00	344.	575.	94.19	1.947	2.416	2.091	.9831
.90	45000.	5.00	2506.	2645.	182.68	5.184	2.416	3.252	.9854
.90	45000.	6.67	1593.	1728.	151.33	3.954	2.415	2.837	.9849
.90	45000.	8.34	851.	1038.	121.00	2.916	2.417	2.513	.9841
.90	45000.	10.00	332.	630.	95.86	2.157	2.416	2.227	.9815
1.00	45000.	5.00	2670.	3001.	182.68	5.798	2.416	3.642	.9832
1.00	45000.	6.67	1629.	1940.	150.96	4.398	2.416	3.313	.9794
1.00	45000.	8.34	780.	1148.	120.84	3.215	2.416	2.674	.9834
1.00	45000.	10.00	198.	675.	95.98	2.363	2.416	2.366	.9793
.25	60000.	5.00	956.	943.	182.68	3.395	2.416	2.557	.9865
.25	60000.	6.67	586.	614.	140.08	2.490	2.415	2.236	.9851
.25	60000.	8.34	302.	384.	101.24	1.702	2.416	2.057	.9850
.25	60000.	10.00	150.	291.	68.58	1.382	2.416	1.986	.9850
.50	60000.	5.00	1008.	1060.	182.68	3.838	2.416	2.664	.9868
.50	60000.	6.67	642.	713.	145.80	2.890	2.417	2.363	.9859
.50	60000.	8.34	352.	458.	109.97	2.107	2.415	2.108	.9838
.50	60000.	10.00	178.	317.	82.35	1.505	2.417	2.031	.9850
.80	60000.	5.00	1200.	1339.	182.68	4.863	2.418	3.178	.9848
.80	60000.	6.67	778.	910.	149.34	3.698	2.416	2.658	.9868
.80	60000.	8.34	441.	590.	117.33	2.739	2.415	2.344	.9856
.80	60000.	10.00	218.	385.	91.38	2.056	2.417	2.103	.9836
.90	60000.	5.00	1294.	1478.	182.09	5.362	2.416	3.267	.9859
.90	60000.	6.67	829.	999.	149.50	4.077	2.415	2.927	.9841
.90	60000.	8.34	464.	649.	118.75	3.024	2.416	2.570	.9841
.90	60000.	10.00	213.	416.	93.17	2.264	2.415	2.266	.9820
1.00	60000.	5.00	1294.	1566.	177.07	5.747	2.417	3.641	.9831
1.00	60000.	6.67	902.	1053.	146.03	4.384	2.416	3.319	.9794
1.00	60000.	8.34	415.	669.	117.32	3.273	2.416	2.732	.9820
1.00	60000.	10.00	151.	442.	93.50	2.471	2.415	2.417	.9796

-1.

SECTION VII

EXAMPLE OF A TERMINAL SESSION

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N>GET,NSLB26,TAPE1=AFE,TAPE51=TEST1,TAPE52=TEST2,TAPE53=TEST3

N>BATCH
C>RFL,60000
RFL,60000.
C>NSLB26
 INPUT NOZZLE THRUST COEFFICIENT(CV) FLAG WHERE
 CV=0  FOR CV FROM ENGINE DECK
 CV=1  FOR CV FROM CV TABLE
 CV=2  FOR CV=1.(PROGRAM DEFAULT)

I>1
 INPUT NOZZLE TYPE WHERE
 NOZZLE=1. FOR ROUND NOZZLE
 NOZZLE=2. FOR 2-D NOZZLE

I>1.
 INPUT CAPTURE AREA OPTION WHERE
 (CONSTANT CAPTURE AREA=1.,VARIABLE OPTION=2.)

I>1.
 INPUT NUMBER OF ENGINES AND ENGINE SCALE FACTOR

I>2. .9
 INPUT POWER SETTINGS FOR GAMMA CALCULATION
 (MAXIMUM POWER SETTING AND INTERMEDIATE POWER SETTING)

I>1. 5.
 INPUT A10 AND A10/A9 REF

I>47.9 4.
 INPUT REFERENCE MASS FLOW RATIO INDEX
 (0. TO USE TABLES 3A AND 3B,  1. FOR MFR=1.0)

I>1.
 INPUT ENGINE PRINT OPTION(NO=1. YES=2.)

I>2.
```

```
INPUT BYPASS MODE INDEX WHERE

XMODE=1. ALL EXCESS INLET AIRFLOW SPILLED EXTERNALLY
XMODE=2. ALL EXCESS INLET AIRFLOW BYPASSED ABOVE MOSBP
XMODE=3. SCHEDULED BYPASS WITH REST OF EXCESS INLET AIRFLOW SPILLED
XMODE=4. OPTIMUM COMBINATION OF BYPASS AND SPILLAGE FOR MIN INLET DRAG
XMODE=5. OPTIMUM COMBINATION OF BYPASS AND SPILLAGE FOR MIN SFCA

I>3.
ENTER 1. FOR BYPASS MODE PRINT OUT   0. OTHERWISE

I>0.
ENTER 1. IF ONLY RECOVERY AND DRAG MAPS ARE ON THE
INLET MAP FILE      ENTER 0. IF THE INLET MAP FILE HAS
ALL INLET MAPS
I>0.


INLET SIZING INPUTS
INPUT ONE OF THE FOLLOWING CODES
1. XMLO,XMHI (SIZING ENVELOPE OPTION)
2. MACH,ALT (SIZING POINT OPTION)
3. ACAPT (INPUT CAPTURE AREA - SQ FT)

I>1.
INPUT XMLO AND XMHI(SIZING ENVELOPE OPTION)

I>.5 2.
CVFLAG=      1.00 XNOZFG=      1.00 CAPOPT=      1.00 SIZEFG=      0.00
ENGNO =      2.00 SCALE =       .90 XDBASE=      1.00 XDMI  =      5.00
A10   =     47.90 A10A9R=      4.00 OPT   =      2.00 OPTB  =      3.00
OPTBP =      0.00 REFMFR =     1.00 TABRF =      0.00
XMLO  =       .50 XMHI  =      2.00
ENTER 1 IF CORRECTION DESIRED, OTHERWISE ENTER 0

I>0
```

```
1                              INLET SIZING DATA


 INLET SIZING POINT  MACH  .80     ALT60000.     WC 164.70
 CAPTURE AREA  4.670 SQ FT

 BEGIN PROCESSING MARK12 DECK
      AIR FORCE TEST CASE

 INPUT NOZZLE THRUST COEFFICIENT(CV) FLAG WHERE
 CV=0  FOR CV FROM ENGINE DECK
 CV=1  FOR CV FROM CV TABLE
 CV=2  FOR CV=1.(PROGRAM DEFAULT)

I>"END"
     4.157 CP SECONDS EXECUTION TIME
C>
```

SECTION VIII

NOMENCLATURE FOR INPUT AND OUTPUT

This section discusses the nomenclature used to define the quantities that appear in the PIPSI interactive input and output data. The nomenclature used in the input data are discussed first, followed by the nomenclature for the output data.

8.1 INPUT DATA NOMENCLATURE

INPUT NAME	DEFINITION	UNITS
A10	Reference cross-sectional area for calculation of nozzle/aftbody drag	ft^2
A10A9R	Ratio of aftbody reference area to maximum nozzle exit area	Dimensionless
CAPOPT	Capture area option input command. CAPOPT = 1 : Constant capture area CAPOPT = 1 : Variable capture area	Dimensionless
CVFLAG	Input command for selecting nozzle thrust coefficient option CV = 0: Use CV from engine deck CV = 1: Use CV from CV table CV = 2: Use CV = 1.0 (program default)	Dimensionless
ENGNO	Number of engines per airplane	Dimensionless
NOZZLE	Input command to specify nozzle type NOZZLE = 1: round nozzle NOZZLE = 2: 2-D nozzle	Dimensionless

OPT	Inlet capture area sizing option input	Dimensionless
	OPT = 1: Sizes capture area for largest size required between a specified low (XMLO) and high (XMHI) Mach numbers.	
	OPT = 2: Sizes capture area to match the engine airflow at a specified Mach-altitude point.	
	OPT = 3: Input a fixed capture area.	
OPTB	Bypass mode index	Dimensionless
	XMODE = 1. All excess inlet airflow spilled externally	
	XMODE = 2. All excess inlet airflow bypassed above MOSBP	
	XMODE = 3. Scheduled bypass with rest of excess inlet airflow spilled	
	XMODE = 4. Optimum combination of bypass and spillage for minimum inlet drag	
	XMODE = 5. Optimum combination of bypass and spillage for minimum SFCA	
OPTBP	Bypass vs. spillage mode printout option	Dimensionless
	1. = bypass printout 0. = no bypass printout	
REFMFR	Reference mass flow ratio index command:	Dimensionless
	REFMFR = 1: MFR = 1.0	
	REFMFR = 0: Use tables 3A and 3B	
SCALE	Scale factor for sizing engine airflow-related data items in engine input data table	Dimensionless

SIZEFG	Interactive command to tell program the source of the input capture area table: SIZEFG = 0: Input from terminal SIZEFG = 1: Input from disk file	Dimensionless
TABRF	Interactive command to the program to use or not use the (2) total drag and recovery maps instead of the basic (14) data maps: TABRF = 0: Do not use drag and recovery maps. TABRF = 1: Use (2) drag and recovery maps	Dimensionless
XDBASE	Interactive input for user to indicate power setting code corresponding to max A/B power.	Dimensionless
XDNI	Interactive input for user to indicate power setting code corresponding to intermediate power.	Dimensionless
XMHI	Maximum Mach number for the inlet sizing envelope.	Dimensionless
XMLO	Minimum Mach number for the inlet sizing envelope.	Dimensionless

8.2 OUTPUT DATA NOMENCLATURE

OUTPUT NAME	DEFINITION	UNITS
CASE	Data point number	Dimensionless
MACH	Free-stream Mach number	Dimensionless
PS	Power setting	Dimensionless
FNA	Installed net thrust	lb
WFT RF	Installed fuel flow	lb/hr
SFCA	Specific fuel consumption	lb/hr lb
FNRF	Uninstalled thrust corrected for total pressure recovery	Dimensionless
FRAM	Ram drag of engine airflow	lb
RF	Inlet total pressure recovery	Dimensionless
REF RF	Total pressure recovery on which uninstalled engine.data is based	Dimensionless
DINLET	Inlet drag	lb
CDSPL	Inlet spillage drag coefficient, Dspill/qoAc	Dimensionless
CDBLD	Inlet bleed drag coefficient, D_{BLD}/q_oA_c	Dimensionless
CDBYP	Inlet bypass drag coefficient, D_{BP}/q_oA_c	Dimensionless
CDINL	Inlet drag coefficient D_{INL}/q_oA_c	Dimensionless
DAFT	Nozzle/aftbody drag, D_{AFT}/q_oA_{10}	lb
CDPS	Power sensitive nozzle/aftbody drag coefficient	Dimensionless

CDAB	Nozzle/aftbody drag coefficient, $D_{AB}/q_o A_{10}$	Dimensionless
CDAB REF	Nozzle/aftbody drag coefficient at reference conditions	Dimensionless
DPS	Power-sensitive nozzle/aftbody drag	lb
P8/PO	Uninstalled nozzle total pressure ratio	Dimensionless
A9	Nozzle exit area	ft^2
A8	Nozzle throat area	ft^2
A10	Aftbody cross-sectional reference area	ft^2
CFG	Nozzle gross thrust coefficient	Dimensionless
A10/A9	Ratio of aftbody cross-sectional to reference area to nozzle exit area	Dimensionless
FN INPUT	Uninstalled net thrust	lb
WF INPUT	Uninstalled fuel flow	lb/hr
SFC INPUT	Uninstalled specific fuel consumption	lb/hr lb
W INPUT	Uninstalled engine corrected airflow	lb/sec
W ABS	Uninstalled engine absolute airflow	lb/sec
FN/DELTA	Installed net thrust divided by δ_{AMB}	lb
WF COR	Installed fuel flow divided by $\delta_{AMB}\sqrt{\theta_{AMB}}$	lb/hr

SFC COR	Installed specific fuel consumption divided by $\sqrt{\theta_{AMB}}$	lb/hr lb
P9/PO	Nozzle exit static pressure ratio	Dimensionless
AOE/AC	Ratio of engine free-stream tube airflow to inlet capture area	Dimensionless
AOI/AC	Ratio of inlet supply free-stream tube airflow to inlet capture area	Dimensionless
AO/AC	Ratio of "engine plus bypass" free-stream tube airflow to inlet capture area	Dimensionless
STATUS	(Not used by current version of the computer program)	-
P8PORF	Installed nozzle total pressure ratio	Dimensionless
WO8RF	Installed nozzle absolute airflow	lb/sec

SECTION IX

SAMPLE OUTPUT DATA

ENGINE PERFORMANCE PROGRAM

ENGINE FILE	=	TAPE1
NOZZLE AFT/BODY DRAG TABLE FILE	=	TAPE52
INLET DATA FILE	=	TAPE51
NOZZLE THRUST COEFFICIENT FILE	=	TAPE53
NUMBER OF ENGINES	=	2.00
ENGINE SCALE FACTOR	=	.20
A10	=	47.96
A10/A9	=	3.00
REFMFR	=	1.00
TABRF	=	0.06
BYPASS OPTION	=	BYPASS VS SPILLAGE FOR MIN SFCA
BYPASS PRINT OPTION	=	ON
MAXIMUM POWER SETTING	=	100.00
INTERMEDIATE POWER SETTING	=	50.00
ENGINE PRINT OPTION	=	ON
NOZZLE TYPE	=	2-D
NOZZLE THRUST COEFFICIENT OPTION	=	CV FROM FILE
CAPTURE AREA MODE	=	CONSTANT
XMDES	=	1.95
ALTDES	=	60000.00

INLET START MACH NUMBER 3.060

TABLE NUMBER 1

0.000	.200	2.000
0.000	.200	2.000

TABLE NUMBER 2A

.550	.700	.850	1.200	1.600	2.600			
.700	.805	.900	1.060	1.655	1.675	1.100		
.992	.991	.985	.969	.950	.933	.875		
.600	.700	.800	.900	.950	.970			
.996	.990	.965	.974	.965	.900			
.500	.600	.700	.803	.850	.875	.905		
.990	.990	.985	.983	.975	.962	.900		
.500	.600	.700	.800	.850	.875	.902		
.980	.979	.977	.973	.967	.955	.960		
.500	.600	.700	.800	.850	.875	.885	.890	
.976	.970	.965	.958	.955	.940	.925	.900	
.500	.690	.700	.860	.900	.930	.935	.943	.950
.958	.953	.949	.944	.935	.925	.920	.980	.650

MINIMUM MACH NUMBER FOR INLET DRAG CALCULATIONS .556

ENRICHED TABLE 2A

.700 .600 .500 .500 .500 .500 0.000 0.000 0.000 0.000

.728	.619	.520	.520	.520	.523	0.000	0.000	0.000	0.000
.740	.637	.541	.540	.539	.545	0.000	0.000	0.000	0.000
.760	.656	.561	.560	.559	.568	0.000	0.000	0.000	0.000
.780	.674	.581	.580	.579	.590	0.000	0.000	0.000	0.000
.800	.693	.601	.601	.598	.613	0.000	0.000	0.000	0.000
.820	.711	.622	.621	.617	.635	0.000	0.000	0.000	0.000
.840	.730	.642	.641	.637	.658	0.000	0.000	0.000	0.000
.860	.748	.662	.661	.656	.680	0.000	0.000	0.000	0.000
.880	.767	.682	.681	.676	.703	0.000	0.000	0.000	0.000
.900	.785	.703	.701	.695	.725	0.000	0.000	0.000	0.000
.907	.791	.709	.708	.702	.733	0.000	0.000	0.000	0.000
.913	.797	.716	.714	.708	.740	0.000	0.000	0.000	0.000
.920	.804	.723	.721	.715	.748	0.000	0.000	0.000	0.000
.927	.810	.730	.728	.721	.755	0.000	0.000	0.000	0.000
.933	.816	.736	.735	.728	.763	0.000	0.000	0.000	0.000
.940	.822	.743	.741	.734	.770	0.000	0.000	0.000	0.000
.947	.828	.750	.748	.741	.778	0.000	0.000	0.000	0.000
.953	.834	.757	.755	.747	.785	0.000	0.000	0.000	0.000
.960	.841	.763	.761	.754	.793	0.000	0.000	0.000	0.000
.967	.847	.770	.768	.760	.800	0.000	0.000	0.000	0.000
.973	.853	.777	.775	.767	.808	0.000	0.000	0.000	0.000
.980	.859	.784	.781	.773	.815	0.000	0.000	0.000	0.000
.987	.865	.790	.788	.780	.823	0.000	0.000	0.000	0.000
.993	.871	.797	.795	.786	.830	0.000	0.000	0.000	0.000
1.000	.878	.804	.802	.793	.838	0.000	0.000	0.000	0.000
1.007	.884	.811	.808	.799	.845	0.000	0.000	0.000	0.000
1.013	.890	.817	.815	.806	.853	0.000	0.000	0.000	0.000
1.020	.896	.824	.822	.812	.860	0.000	0.000	0.000	0.000
1.027	.902	.831	.828	.819	.868	0.000	0.000	0.000	0.000
1.033	.908	.838	.835	.825	.875	0.000	0.000	0.000	0.000
1.040	.915	.844	.842	.832	.883	0.000	0.000	0.000	0.000
1.047	.921	.851	.848	.838	.890	0.000	0.000	0.000	0.000
1.053	.927	.858	.855	.845	.898	0.000	0.000	0.000	0.000
1.060	.933	.865	.862	.851	.905	0.000	0.000	0.000	0.000
1.067	.939	.871	.869	.858	.913	0.000	0.000	0.000	0.000
1.073	.945	.878	.875	.864	.920	0.000	0.000	0.000	0.000
1.080	.952	.885	.882	.871	.928	0.000	0.000	0.000	0.000
1.087	.958	.892	.889	.877	.935	0.000	0.000	0.000	0.000
1.093	.964	.898	.895	.884	.943	0.000	0.000	0.000	0.000
1.100	.970	.905	.902	.890	.950	0.000	0.000	0.000	0.000

.992	.993	.990	.980	.976	.958	0.000	0.000	0.000	0.000
.991	.990	.990	.980	.975	.957	0.000	0.000	0.000	0.000
.991	.990	.990	.980	.974	.956	0.000	0.000	0.000	0.000
.991	.990	.990	.979	.972	.955	0.000	0.000	0.000	0.000
.991	.990	.990	.979	.971	.954	0.000	0.000	0.000	0.000
.991	.990	.990	.979	.970	.953	0.000	0.000	0.000	0.000
.990	.989	.990	.979	.969	.952	0.000	0.000	0.000	0.000
.989	.989	.990	.978	.968	.951	0.000	0.000	0.000	0.000
.987	.988	.989	.978	.967	.950	0.000	0.000	0.000	0.000
.986	.987	.989	.977	.966	.949	0.000	0.000	0.000	0.000
.985	.986	.989	.977	.965	.948	0.000	0.000	0.000	0.000
.984	.985	.988	.977	.965	.947	0.000	0.000	0.000	0.000
.983	.985	.988	.976	.964	.947	0.000	0.000	0.000	0.000
.982	.985	.988	.976	.964	.947	0.000	0.000	0.000	0.000
.981	.984	.987	.976	.964	.946	0.000	0.000	0.000	0.000
.980	.983	.987	.976	.963	.946	0.000	0.000	0.000	0.000
.979	.983	.986	.975	.953	.945	0.000	0.000	0.000	0.000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

.976	.981	.986	.975	.962	.945	0.000	0.000	0.000	0.000
.975	.981	.985	.975	.961	.944	0.000	0.000	0.000	0.000
.974	.980	.985	.974	.961	.944	0.000	0.000	0.000	0.000
.973	.979	.984	.974	.960	.943	0.000	0.000	0.000	0.000
.972	.979	.984	.974	.960	.943	0.000	0.000	0.000	0.000
.971	.978	.984	.973	.959	.942	0.000	0.000	0.000	0.000
.970	.977	.983	.973	.959	.941	0.000	0.000	0.000	0.000
.969	.976	.982	.973	.959	.941	0.000	0.000	0.000	0.000
.967	.976	.981	.972	.958	.940	0.000	0.000	0.000	0.000
.964	.975	.980	.971	.958	.939	0.000	0.000	0.000	0.000
.962	.974	.979	.970	.957	.939	0.000	0.000	0.000	0.000
.960	.973	.978	.970	.957	.938	0.000	0.000	0.000	0.000
.957	.969	.977	.969	.956	.937	0.000	0.000	0.000	0.000
.955	.966	.976	.968	.956	.937	0.000	0.000	0.000	0.000
.953	.962	.974	.967	.956	.936	0.000	0.000	0.000	0.000
.951	.958	.971	.965	.955	.935	0.000	0.000	0.000	0.000
.946	.955	.967	.961	.954	.933	0.000	0.000	0.000	0.000
.940	.951	.964	.958	.950	.931	0.000	0.000	0.000	0.000
.934	.948	.955	.935	.947	.928	0.000	0.000	0.000	0.000
.921	.942	.942	.941	.943	.926	0.000	0.000	0.000	0.000
.906	.928	.928	.927	.937	.920	0.000	0.000	0.000	0.000
.890	.916	.914	.916	.927	.901	0.000	0.000	0.000	0.000
.875	.903	.900	.900	.900	.850	0.000	0.000	0.000	0.000

TABLE NUMBER 2B

0.000	.200	.400	.600	.800	1.000	1.200	1.600	2.000
.900	.950	.955	.972	.973	.975	.967	.948	.925

TABLE NUMBER 2C

.468	.600	.800	1.000	1.200	1.600	2.000
1.310	.968	.853	.830	.840	.672	.915

TABLE NUMBER 2D

0.000	1.399	1.400	1.600	1.800	2.000
0.000	0.000	.409	.500	.560	.600

TABLE NUMBER 2E

.550	.700	.800	1.200	1.600	2.000
1.855	.935	.890	.856	.898	.935

TABLE NUMBER 3

0.060	.549	.550	.700	.850	1.200	1.400	1.600	2.000
0.000	1.000							
0.000	0.000							
0.000	1.000							
0.000	0.000							
.300	.400	.500	.600	.700	.800	.900	1.000	
.185	.110	.052	.015	.002	0.000	0.000	0.000	
.300	.400	.500	.600	.700	.800	.900	1.000	
.310	.207	.123	.062	.032	.015	.065	0.000	
.300	.400	.500	.600	.700	.800	.900	1.000	
.410	.240	.175	.096	.056	.026	.016	0.000	
.300	.400	.500	.600	.700	.800	.900	1.000	
.500	.360	.248	.150	.086	.038	.014	0.000	
.300	.500	.700	.805	.887	1.000			
.750	.437	.210	.110	.022	0.000			
.500	.600	.700	.800	.915	1.000			
.715	.350	.370	.210	.021	0.000			
.500	.700	.800	.930	.957	1.000			
.640	.440	.296	.112	.016	0.000			

TABLE NUMBER 3A

0.000	1.000	2.000
0.200	0.000	0.000

TABLE NUMBER 3B

0.000	1.000	2.000
1.000	1.000	1.000

TABLE NUMBER 4

0.000	.849	.850	1.200	1.700	2.000
0.000	.010	.020	.040	.060	
0.000	0.000	0.000	0.000	0.000	
0.000	0.000	0.000	0.000	0.000	
0.000	.007	.014	.028	.042	
0.000	.010	.021	.042	.063	
0.000	.011	.022	.044	.066	
0.000	.013	.026	.052	.078	

TABLE NUMBER 5

0.000	.849	.850	1.000	1.200	1.500	1.700	2.200
0.000	.040	.080	.120	.160	.200	.240	
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
0.000	0.050	0.000	0.000	0.000	0.000	0.000	
0.000	.062	.125	.193	.260	.380	.500	
0.000	.050	.100	.156	.217	.290	.375	
0.000	.036	.075	.117	.162	.220	.293	
0.000	.030	.062	.097	.135	.165	.241	
0.000	.025	.052	.081	.116	.160	.216	
0.000	.020	.045	.074	.110	.153	.210	

TABLE NUMBER 6A

0.000	.800	1.000	1.200	1.400	1.600	1.800	2.000
0.000	1.000						
0.000	0.000						
0.000	1.000						
0.000	0.000						
.600	.700	.31	.900	1.000			
.008	.007	.005	.003	0.000			
.630	.700	.849	.900	1.000			
.014	.013	.010	.008	0.000			
.600	.700	.859	.900	1.000			
.022	.020	.015	.012	0.000			
.600	.700	.800	.881	.930	1.000		
.030	.029	.026	.020	.014	0.000		
.600	.700	.800	.906	.930	1.000		
.044	.042	.037	.025	.021	0.000		
.600	.700	.800	.900	.930	1.000		
.060	.056	.050	.037	.030	0.000		

TABLE NUMBER 6B

0.000	.800	1.200	1.600	2.000
0.000	0.000	.010	.020	.030

TABLE NUMBER 7

0.000	1.399	1.400	1.600	1.800	2.000
0.000	1.000				
0.000	0.000				
0.000	1.000				
0.000	0.000				
.400	.854	1.000			
.461	.005	0.000			

.400	.872	1.000
.443	.010	0.000
.400	.892	1.000
.506	.614	0.000
.400	.915	1.000
.532	.015	0.000

TABLE NUMBER A22

10.000	5.010	3.333	2.500	2.030	1.667				
.200	.800	.900	.950	1.050	1.200	1.400	1.600	2.000	3.000
.025	.025	.031	.043	.153	.138	.134	.132	.131	.131
.019	.019	.021	.027	.119	.098	.091	.085	.084	.084
.013	.013	.014	.018	.085	.067	.062	.052	.050	.050
.009	.009	.010	.013	.067	.049	.041	.032	.029	.029
.007	.007	.008	.010	.049	.037	.030	.021	.018	.018
.005	.006	.006	.008	.039	.030	.024	.016	.014	.014

TABLE NUMBER B25

100.000	50.000								
2.000	3.000	4.000	5.000	6.000	8.000	10.000	12.000	14.000	16.000
.980	.980	.979	.979	.977	.977	.976	.975	.974	.973
.946	.957	.964	.969	.966	.964	.965	.966	.965	.960

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FROM COPY FURNISHED TO DDC

INLET SIZING DATA

INLET SIZING POINT MACH 1.95 ALT60000. WC 113.40
CAPTURE AREA 3.791 SQ FT

ALTITUDE 0. AIR FORCE TEST CASE

CAPTURE AREA 3.79 A10/A9 REF 3.600 A10 47.90
PAMB 2116.2 TAMB 518.7 TTG 518.7 Q 0.0

CASE	1.000	CASE
MACH	0.000	MACH
PS	1.000	PS
FNA	13640.422	FXA
WFT RF	29550.420	WFT RF
SFCA	2.166	SFCA
FNRF	13640.422	FNRF
FRAM	0.000	FRAM
RF	.900	RF
REF RF	1.000	REF RF
DINLET	0.000	DINLET
CDSPL	0.000	CDSPL
CDBLB	0.000	CDBLB
CDBYP	0.000	CDBYP
CDINL	0.000	CDINL
DAFT	0.000	DAFT
CDPS	0.000	CDPS
CDAB	0.000	CDAB
CDAB REF	0.000	CDAB REF
BPS	0.000	BPS
P8/P0	2.767	P8/P0
A9	3.522	A9
A8	3.378	A8
CV	.951	CV
A10/A9	6.801	A10/A9
FN INPUT	16493.400	FG INPUT
WF INPUT	32833.600	WF INPUT
SFC INPUT	1.991	SFC INPUT
W INPUT	164.412	W INPUT
W ABS	164.412	W ABS
FN/DELTA	13640.422	FN/DELTA
WF COR	29550.420	WF COR
SFC COR	2.166	SFC COR
P9/P0	1.464	P9/P0
A0E/AC	0.904	A0E/AC
A0I/AC	0.000	A0I/AC
A0/AC	0.000	A0/AC
STATUS	0.000	STATUS
PEPORF	2.450	PEPORF
WDORF	147.971	WDORF

SFCOUT	FNA	RF	CDINL	CDSPL	CDBLD	CDBYP	AOBPAC	AOIAC	AOAC	AOEAC	AOBAC
2.3974	22532.4734	.9370	.1017	.0574	.0442	0.0000	0.0000	.9290	.8960	.8940	.0349
2.3963	22532.0843	.9364	.0993	.0537	.0438	.0018	.0031	.9312	.8966	.8935	.0346
2.3948	22530.1368	.9357	.0969	.0499	.0434	.0036	.0063	.9334	.8992	.8928	.0343
2.3938	22517.7915	.9348	.0947	.0464	.0429	.0055	.0097	.9355	.9017	.8919	.0338
2.3927	22505.0813	.9339	.0925	.0429	.0422	.0075	.0132	.9376	.9043	.8910	.0333
2.3916	22491.9916	.9329	.0901	.0392	.0414	.0095	.0170	.9398	.9071	.8901	.0327
2.3904	22478.3575	.9319	.0877	.0353	.0406	.0117	.0209	.9421	.9100	.8891	.0321

SFCOUT	FNA	RF	CDINL	CDSPL	CDBLD	CDBYP	AOBPAC	AOIAC	AOAC	AOEAC	AOBAC
2.0101	15222.8168	.9370	.1017	.0574	.0442	0.0000	0.0000	.9290	.8960	.8940	.0349
2.0081	15228.3001	.9364	.0993	.0537	.0438	.0018	.0031	.9312	.8966	.8935	.0346
2.0062	15231.3665	.9357	.0969	.0499	.0434	.0036	.0063	.9334	.8992	.8928	.0343
2.0049	15226.6453	.9348	.0947	.0464	.0429	.0055	.0097	.9355	.9017	.8919	.0338
2.0035	15221.8507	.9339	.0925	.0429	.0422	.0075	.0132	.9376	.9043	.8910	.0333
2.0020	15217.8392	.9329	.0901	.0392	.0414	.0095	.0170	.9398	.9071	.8901	.0327
2.0035	15212.0565	.9319	.0877	.0353	.0406	.0117	.0209	.9421	.9100	.8891	.0321

SFCOUT	FNA	RF	CDINL	CDSPL	CDBLD	CDBYP	AOBPAC	AOIAC	AOAC	AOEAC	AOBAC
2.1071	6844.7687	.9370	.1017	.0574	.0442	0.0000	0.0000	.9290	.8960	.8940	.0349
2.1025	6855.4047	.9364	.0993	.0537	.0438	.0018	.0031	.9312	.8966	.8935	.0346
2.0982	6864.3765	.9357	.0969	.0499	.0434	.0036	.0063	.9334	.8992	.8928	.0343
2.0952	6867.3904	.9348	.0947	.0464	.0429	.0055	.0097	.9355	.9017	.8919	.0338
2.0921	6870.6503	.9339	.0925	.0429	.0422	.0075	.0132	.9376	.9043	.8910	.0333
2.0888	6874.2362	.9329	.0901	.0392	.0414	.0095	.0170	.9398	.9071	.8901	.0327
2.0856	6876.0367	.9319	.0877	.0353	.0406	.0117	.0209	.9421	.9100	.8891	.0321

ALTITUDE 22500.   AIR FORCE TEST CASE

CAPTURE AREA 3.79   A10/A9 REF 3.000   A10 47.90
PAMB 873.3   TAMB 430.5   TT3 771.9   Q 2324.5

CASE	45.000	46.000	47.000	CASE
MACH	1.950	1.950	1.950	MACH
PS	4.000	4.000	4.000	PS
FNA	22470.357	15212.057	6878.037	FNA
WFT RF	53731.984	30431.261	14343.138	WFT RF
SFCA	2.390	2.000	2.085	SFCA
FNRF	23543.654	16849.462	9472.851	FNRF
FRAM	15637.712	15637.712	15637.712	FRAM
RF	.932	.932	.932	RF
REF RF	.930	.930	.930	REF RF
DINLET	772.586	772.586	772.586	DINLET
CDSPL	.033	.035	.035	CDSPL
CDBLD	.041	.041	.041	CDBLD
CDBYP	.012	.012	.012	CDBYP
CDINL	.088	.088	.088	CDINL
DAFT	1930.943	2619.743	3696.269	DAFT
CDPS	.005	.016	.033	CDPS
CDAB	.035	.047	.066	CDAB
CDAB REF	.029	.032	.034	CDAB REF
DPS	292.711	864.839	1821.429	DPS
P8/P0	11.062	11.257	11.424	P8/P0
A9	7.252	6.062	4.850	A9
A8	3.416	2.826	2.237	A8
CV	.966	.956	.966	CV
A10/A9	3.303	3.951	4.949	A10/A9
FN INPUT	24155.100	17305.200	9824.400	FN INPUT
WF INPUT	52624.700	30370.500	14314.500	WF INPUT
SFC INPUT	2.220	1.755	1.457	SFC INPUT
W INPUT	110.367	110.367	110.367	W INPUT
W ABS	251.385	251.385	251.385	W ABS
FN/DELTA	54469.483	36862.077	16666.959	FN/DELTA
WF COR	141617.908	80205.702	37803.280	WF COR
SFC COR	2.600	2.176	2.268	SFC COR
P9/P0	1.054	.952	.878	P9/P0
A9E/AC	.889	.889	.889	A9E/AC
A0I/AC	.942	.942	.942	A0I/AC
A0/AC	.910	.910	.910	A0/AC
STATUS	0.000	0.000	0.000	STATUS
P8P0RF	11.085	11.280	11.447	P8P0RF
W0BRF	251.886	251.888	251.886	W0BRF

SECTION X

FLOW CHARTS

This section contains flow charts showing the operation of the PIPSI computer program.

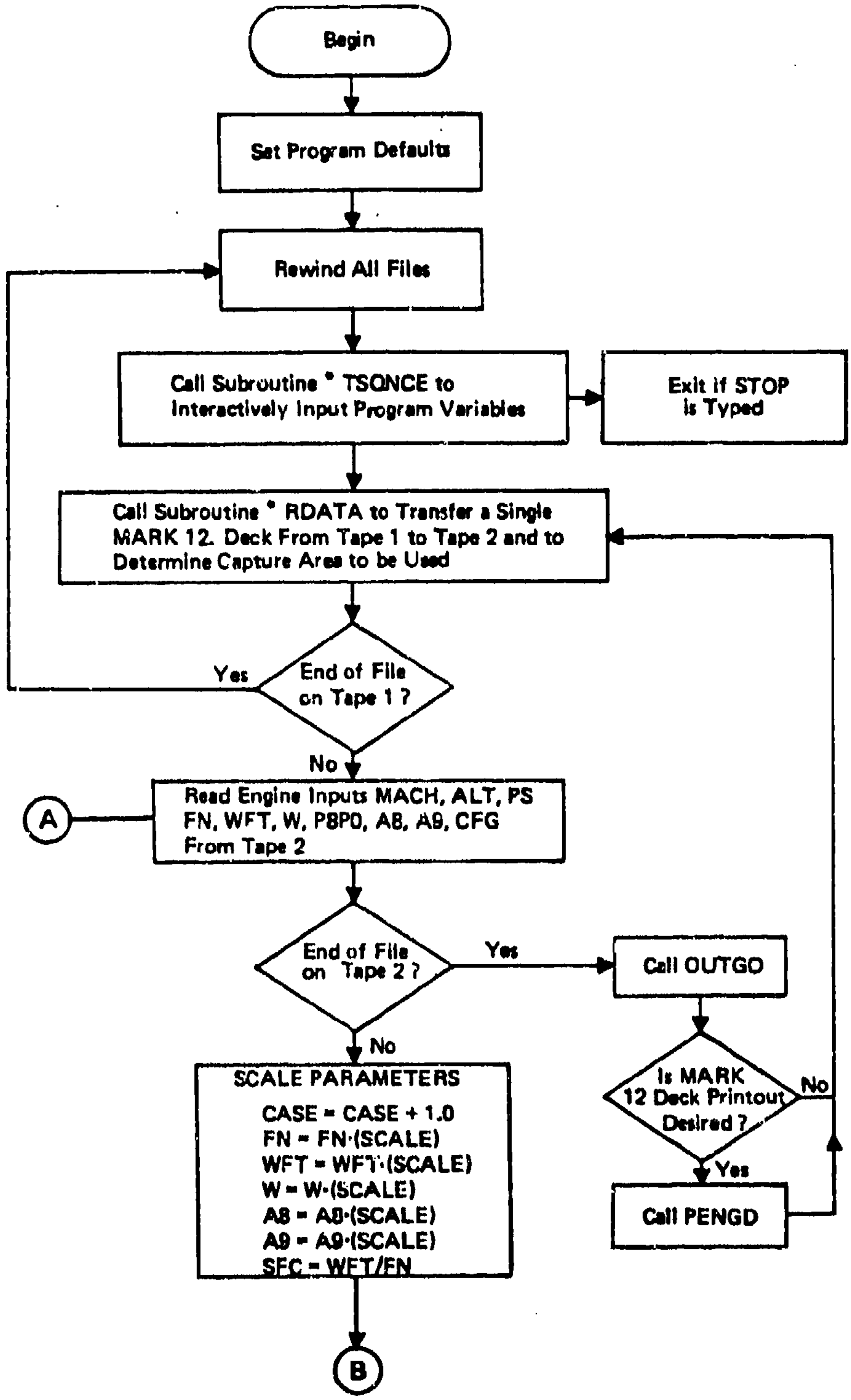

Figure 13. P.I.P.S.I. Main Program (Continued)

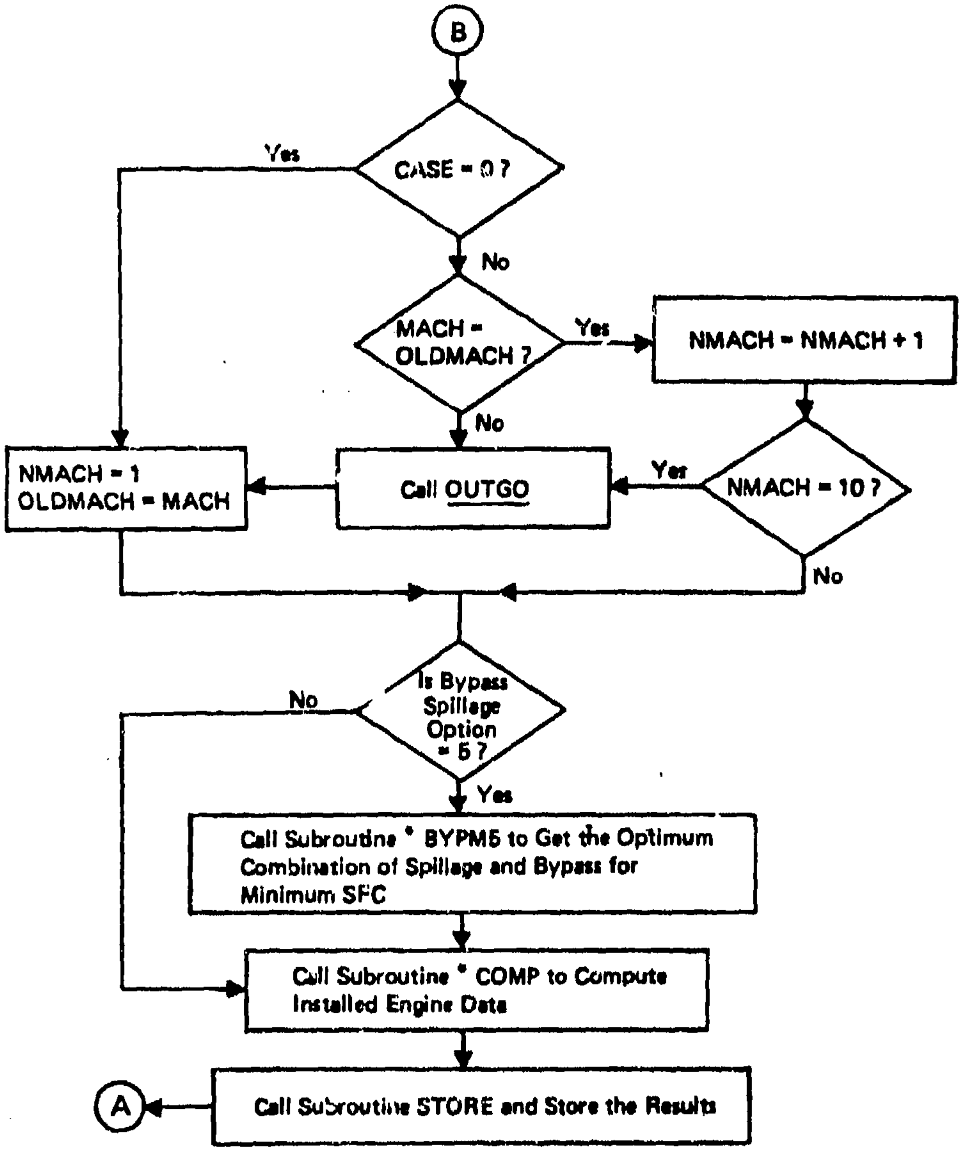

Figure 13. P.I.P.S.I. Main Program (Concluded)

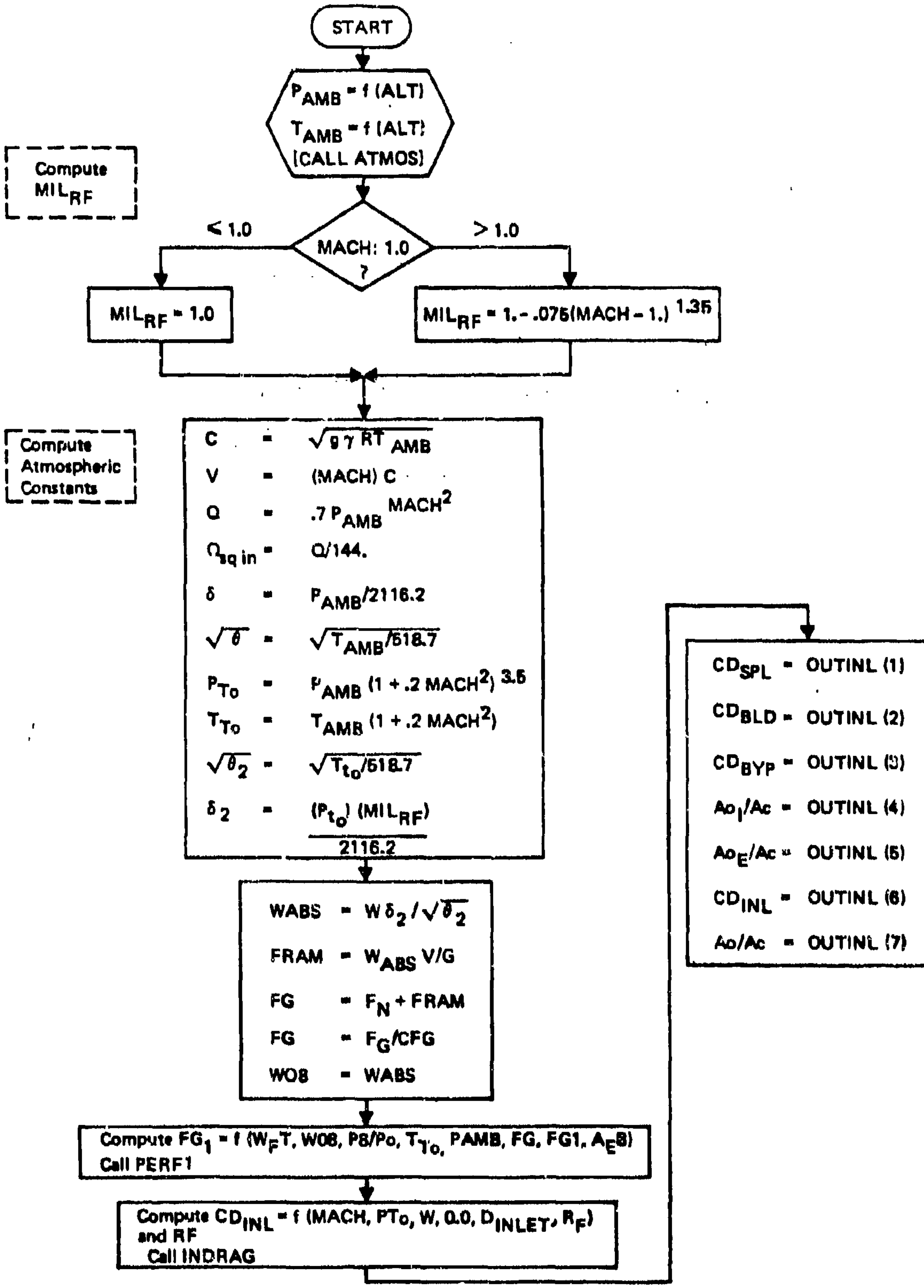

Figure 14. Subroutine COMP (Continued)

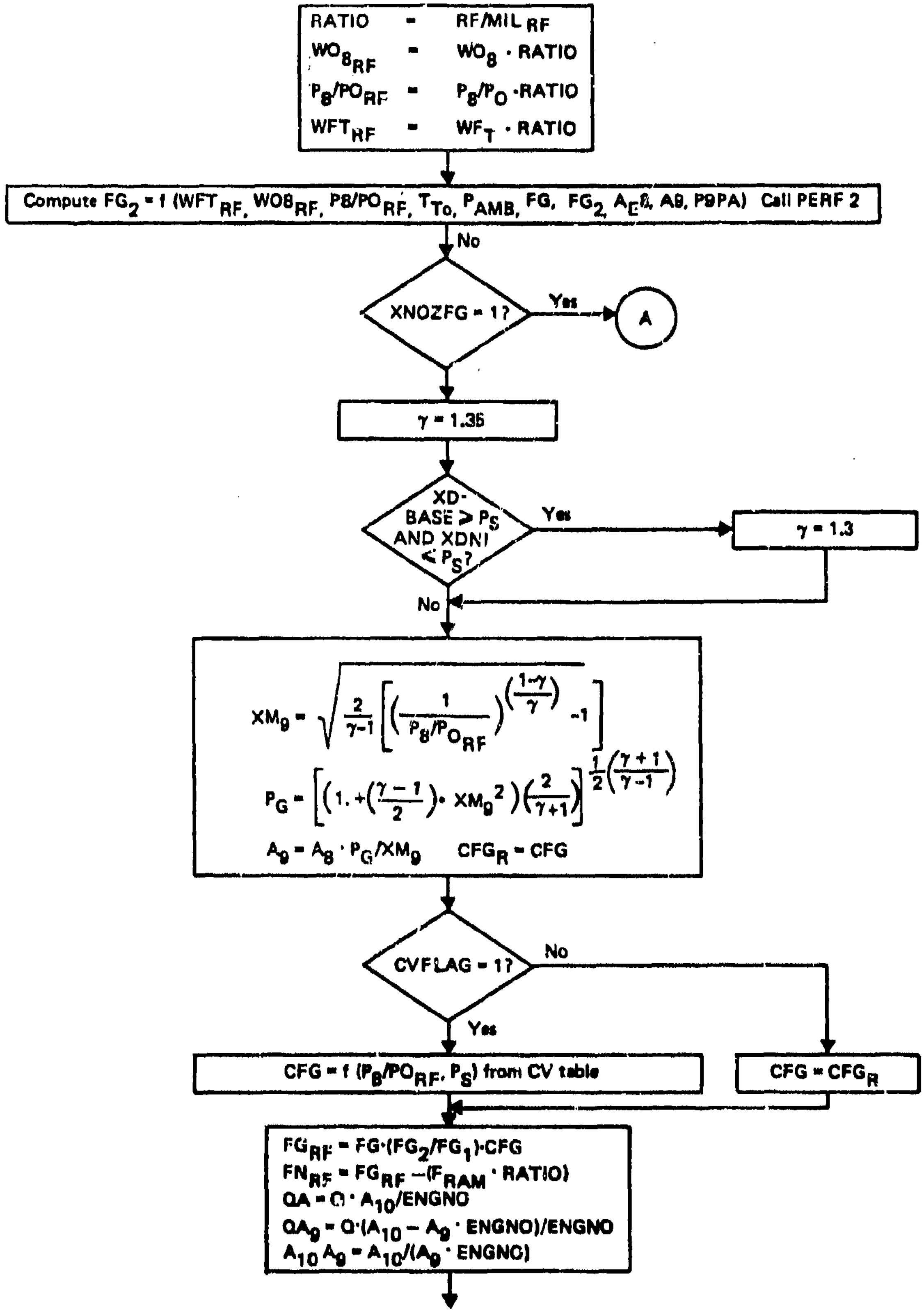

Figure 14. Subroutine COMP (Continued)

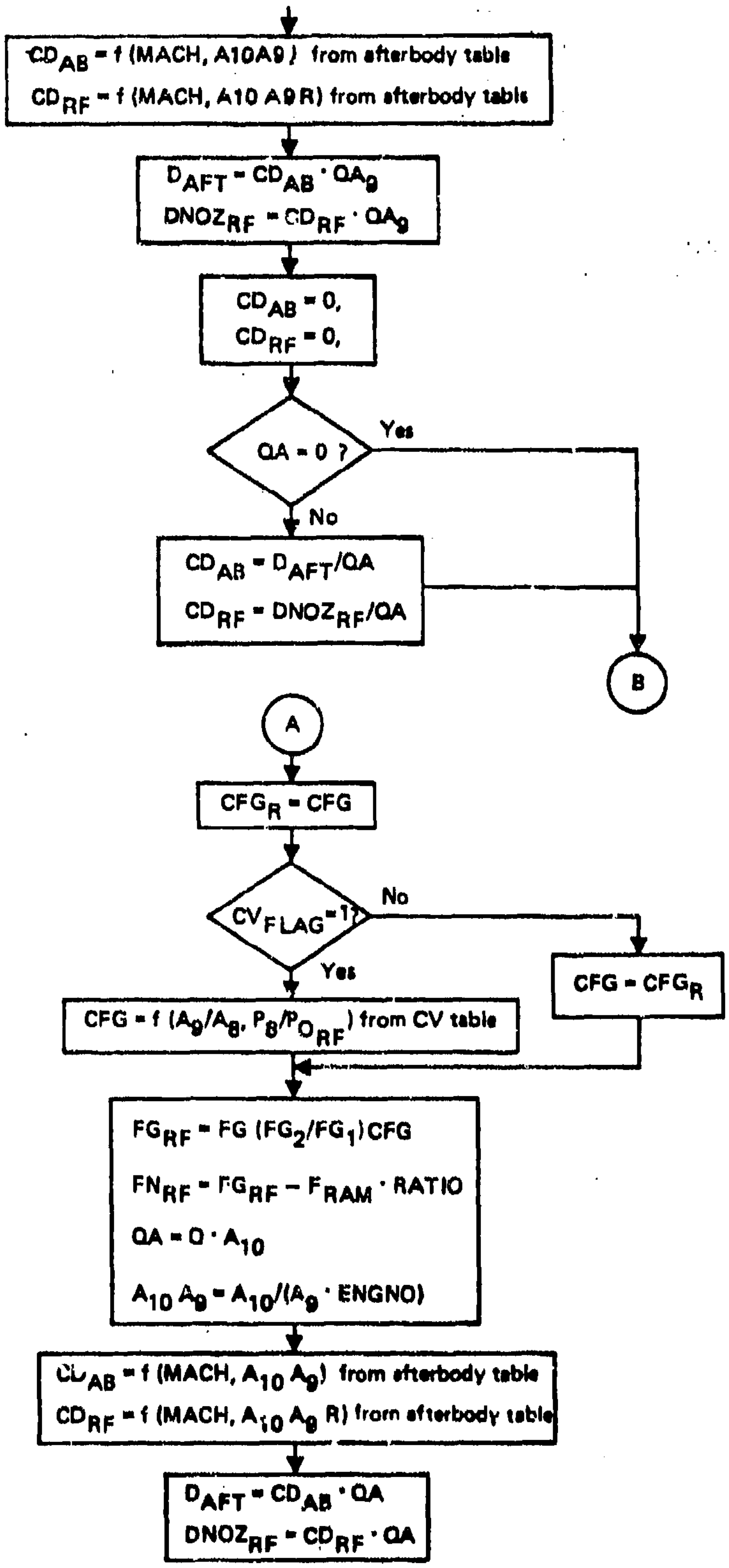

Figure 14. Subroutine COMP (Continued)

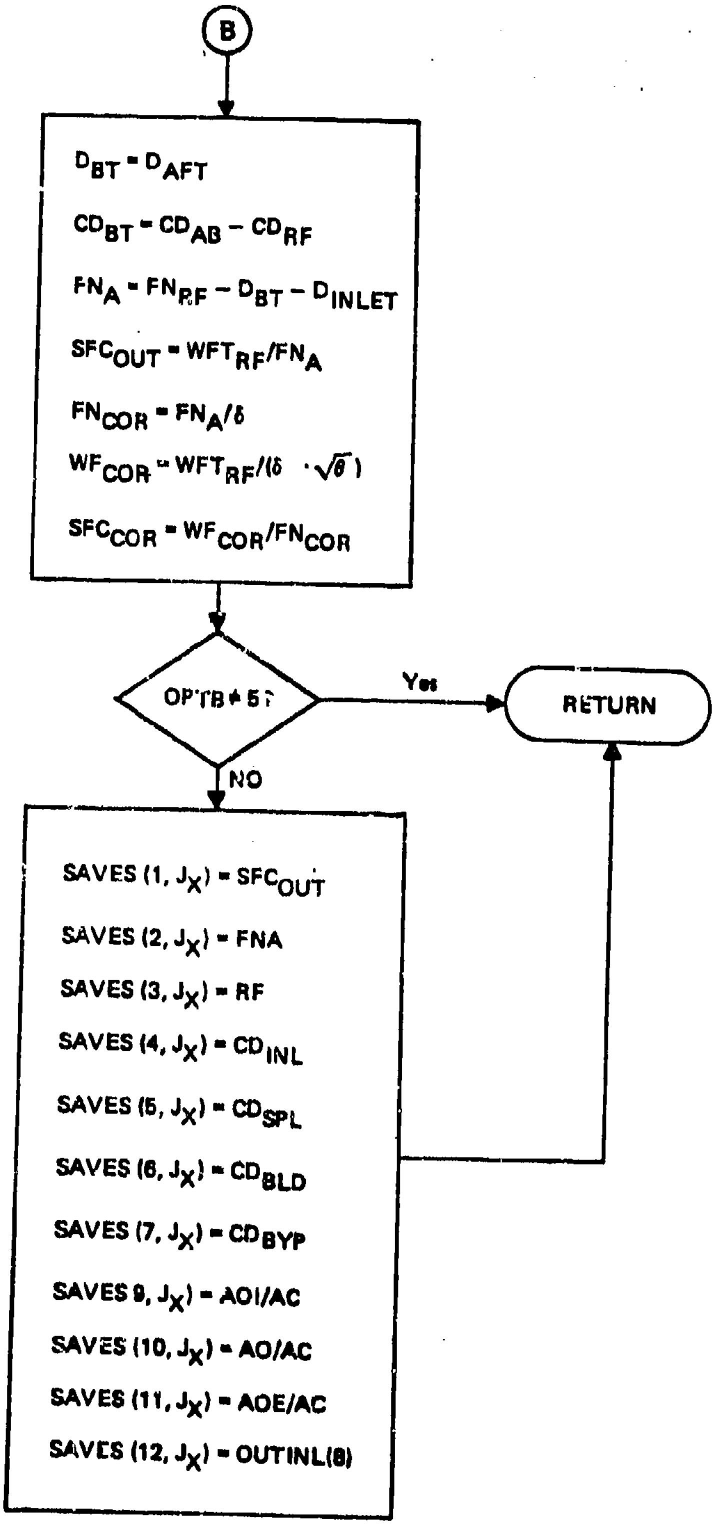

Figure 14. Subroutine COMP (Concluded)

Subroutine BYPM5—Determines a Combination of Bypass and Spillage Using Subroutine COMP—The Results are Used by Subroutine BYSPL

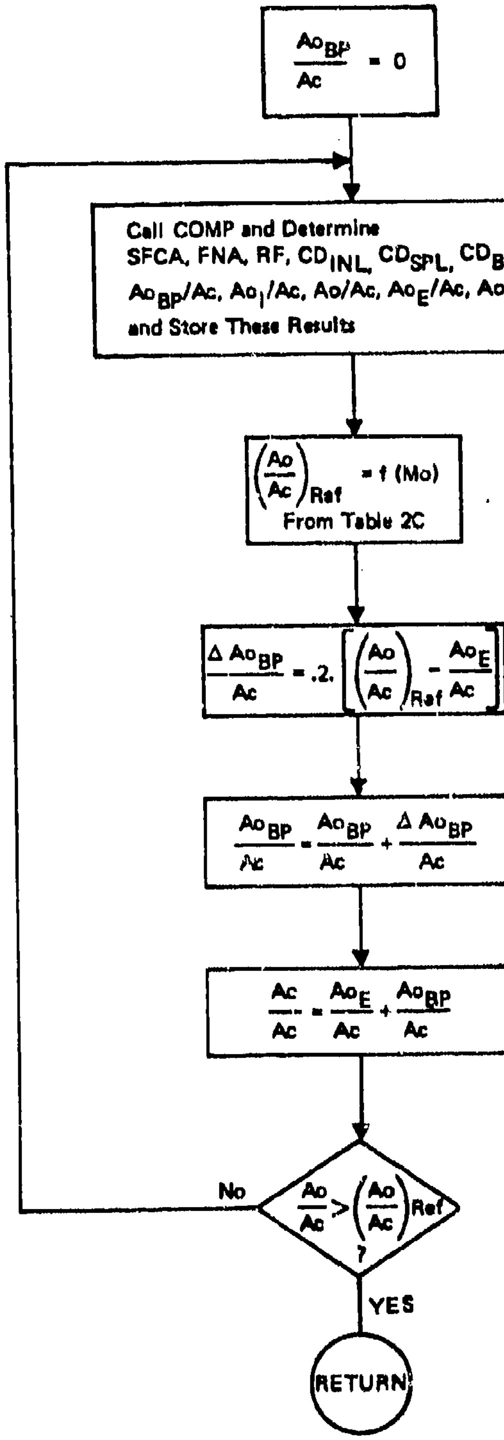

Figure 15. Subroutine BYPM5

Subroutine BYSPL—Determines AOBPAC Depending on Bypass Spillage Option Input By User

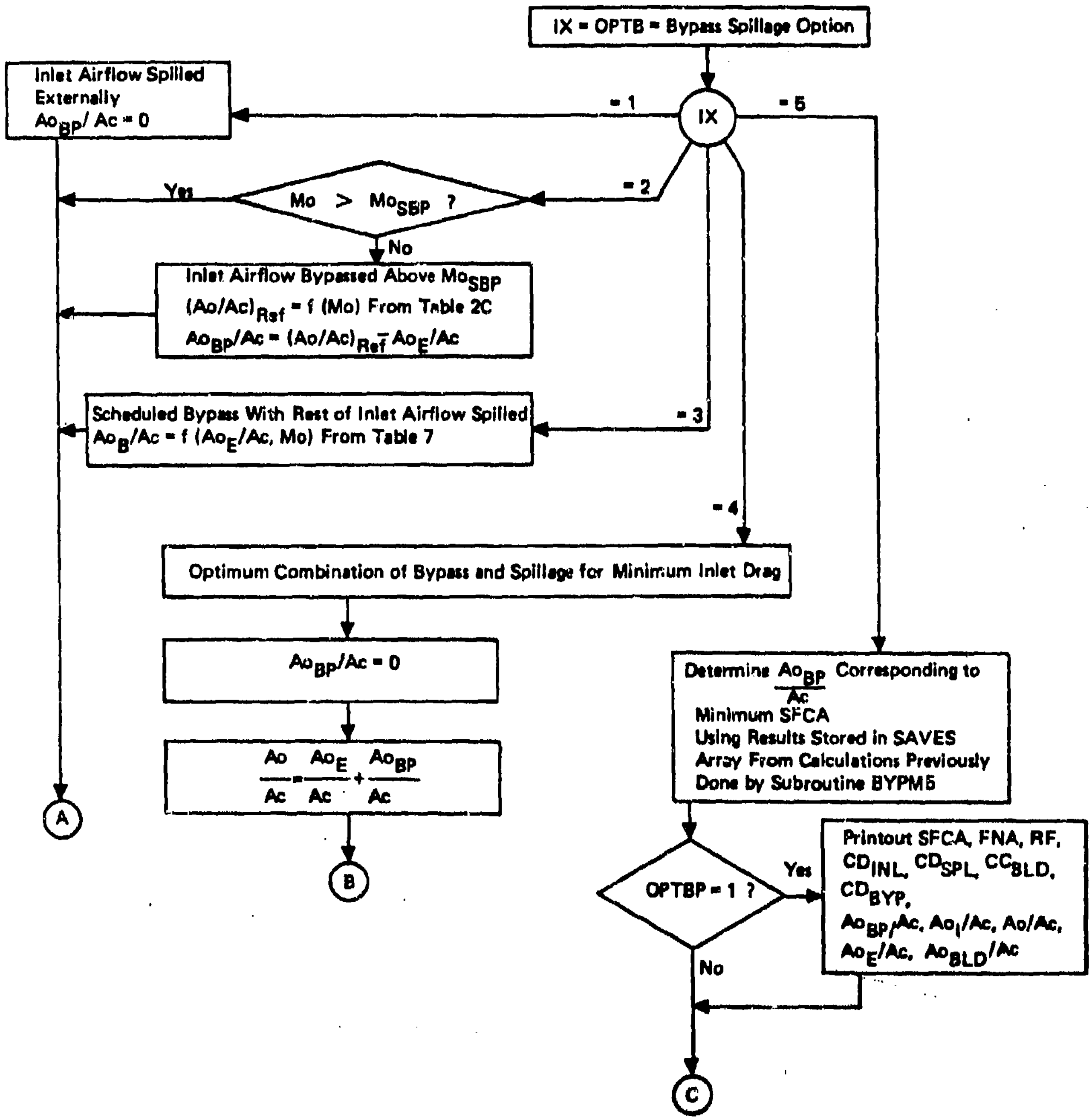

Figure 16. Subroutine BYSPL (Continued)

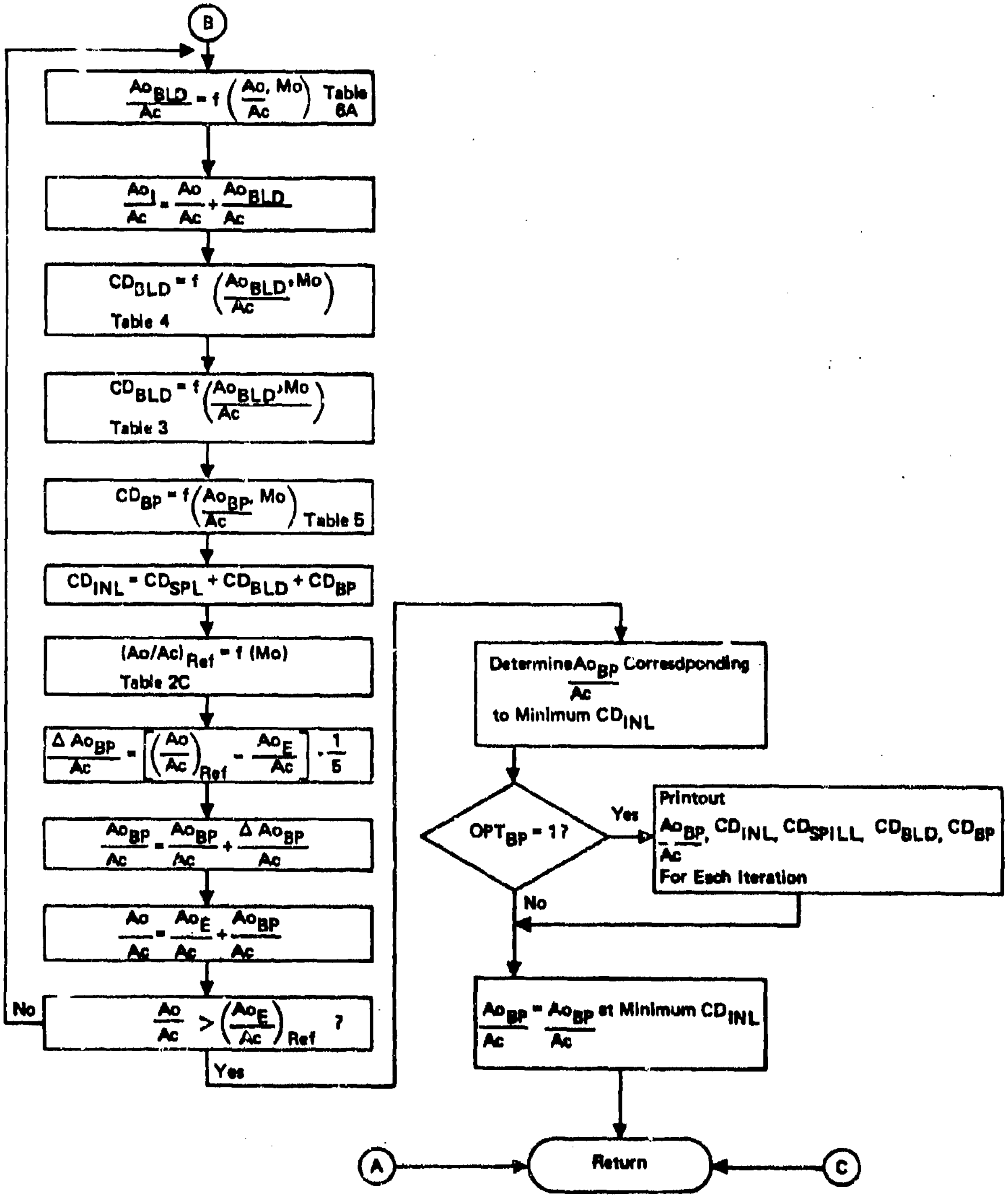

Figure 16. Subroutine BYSPL (Concluded)

Subroutine INDRAG

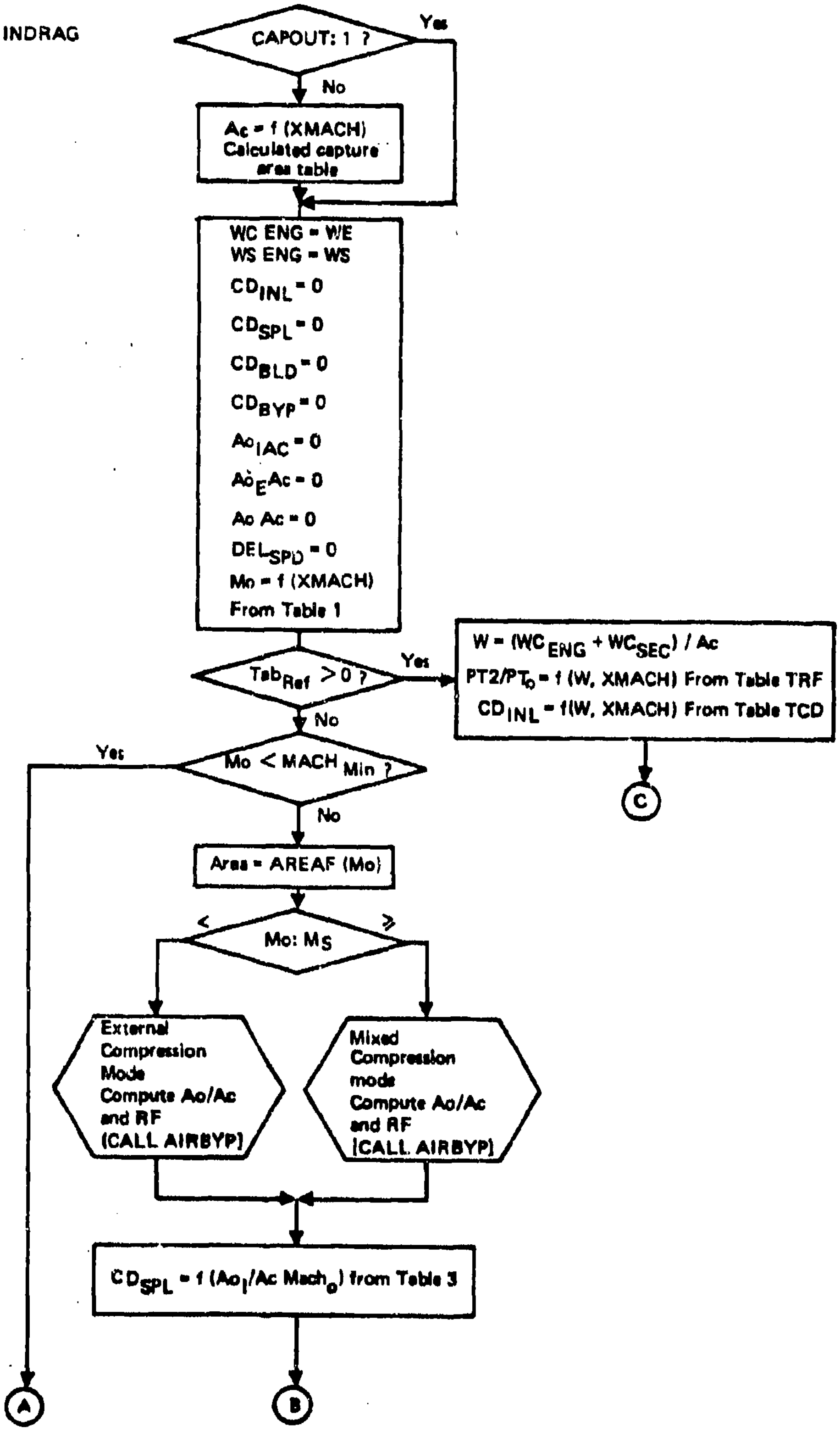

Figure 17. Subroutine INDRAG (Continued)

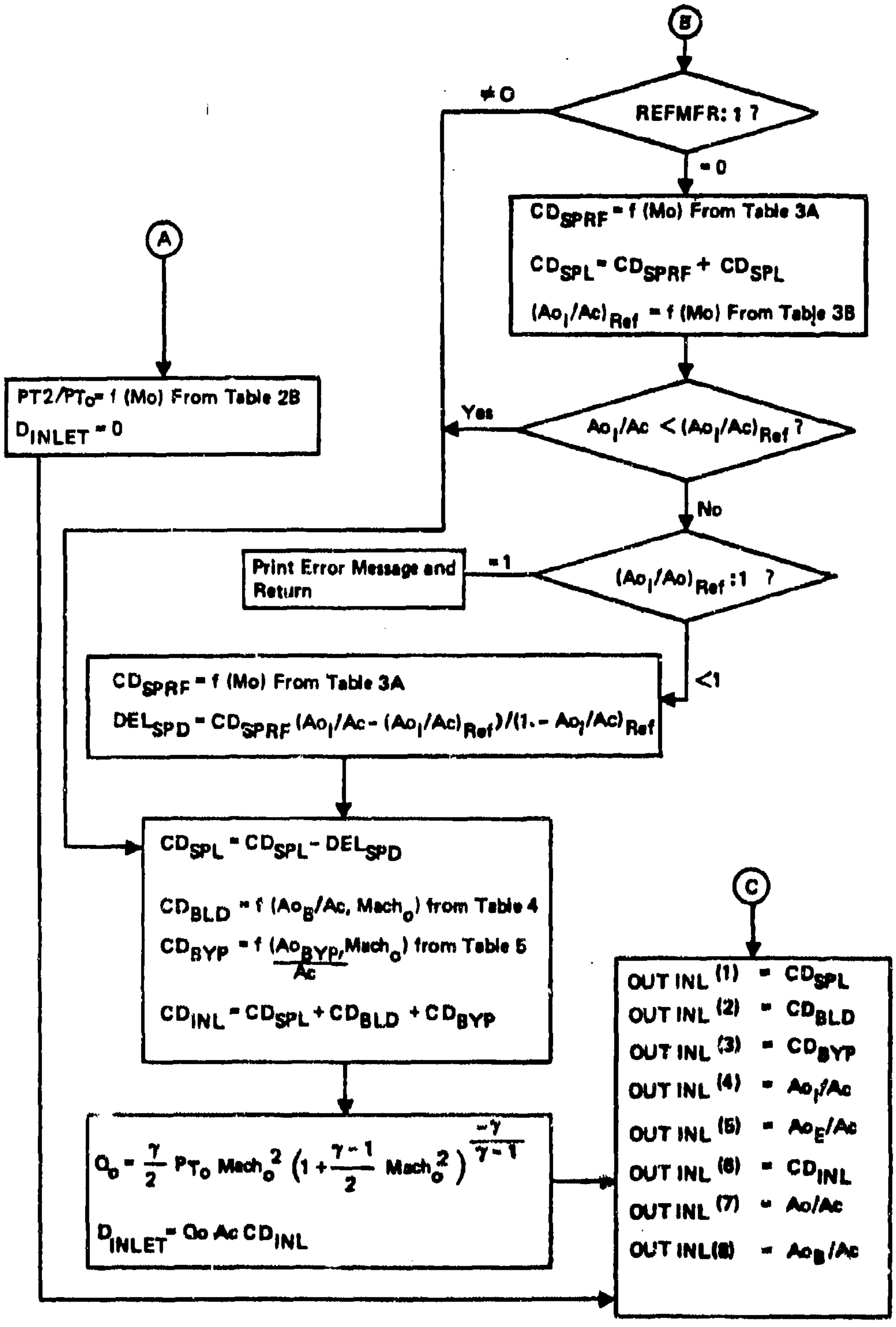

Figure 17. Subroutine INDRAG (Concluded)

Subroutine RDATA—Transfers Engine Data From Tape 1 to Tape 2 and Determines Capture Area Schedule to be Used

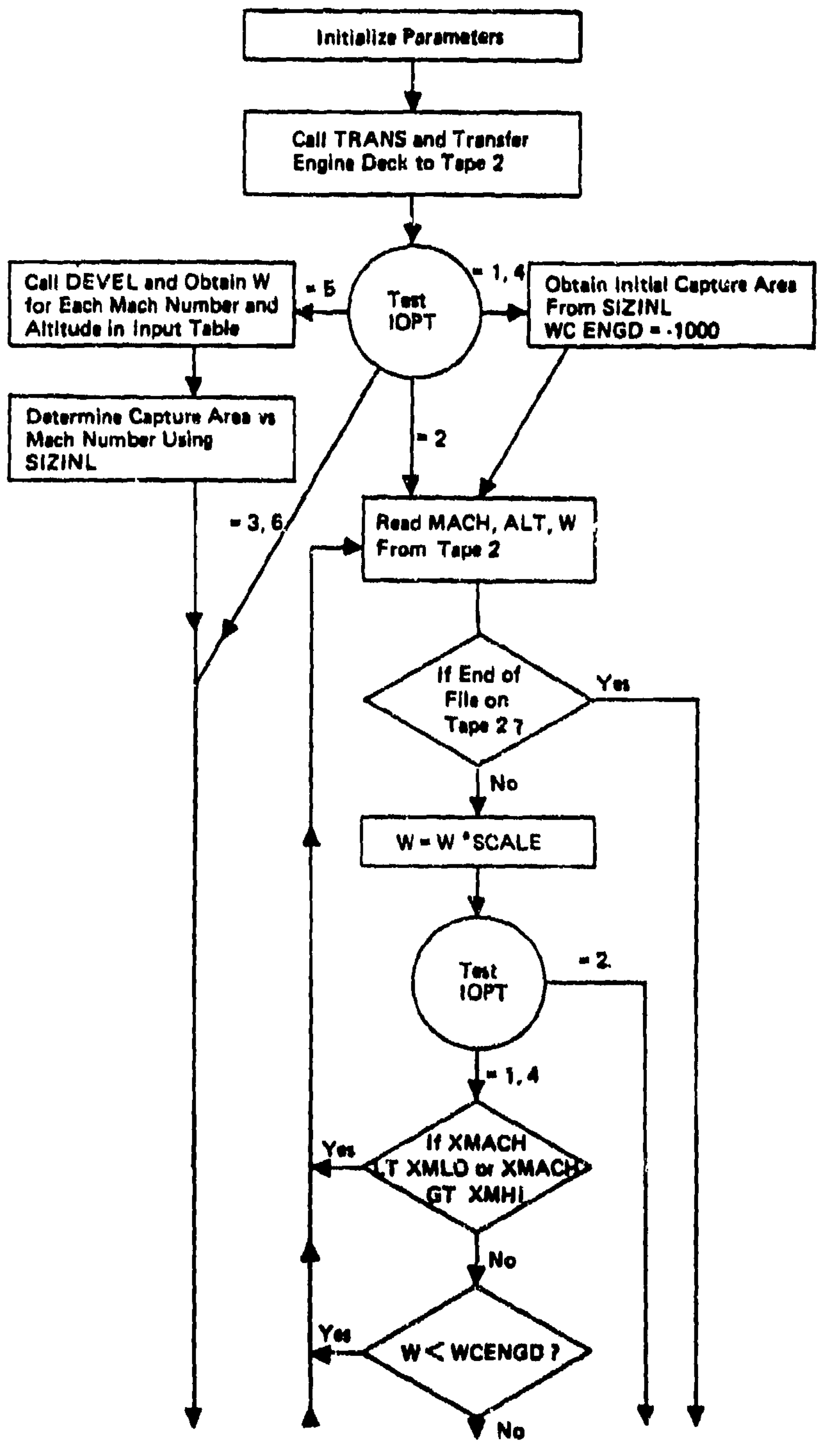

Figure 18. Subroutine RDATA (Continued)

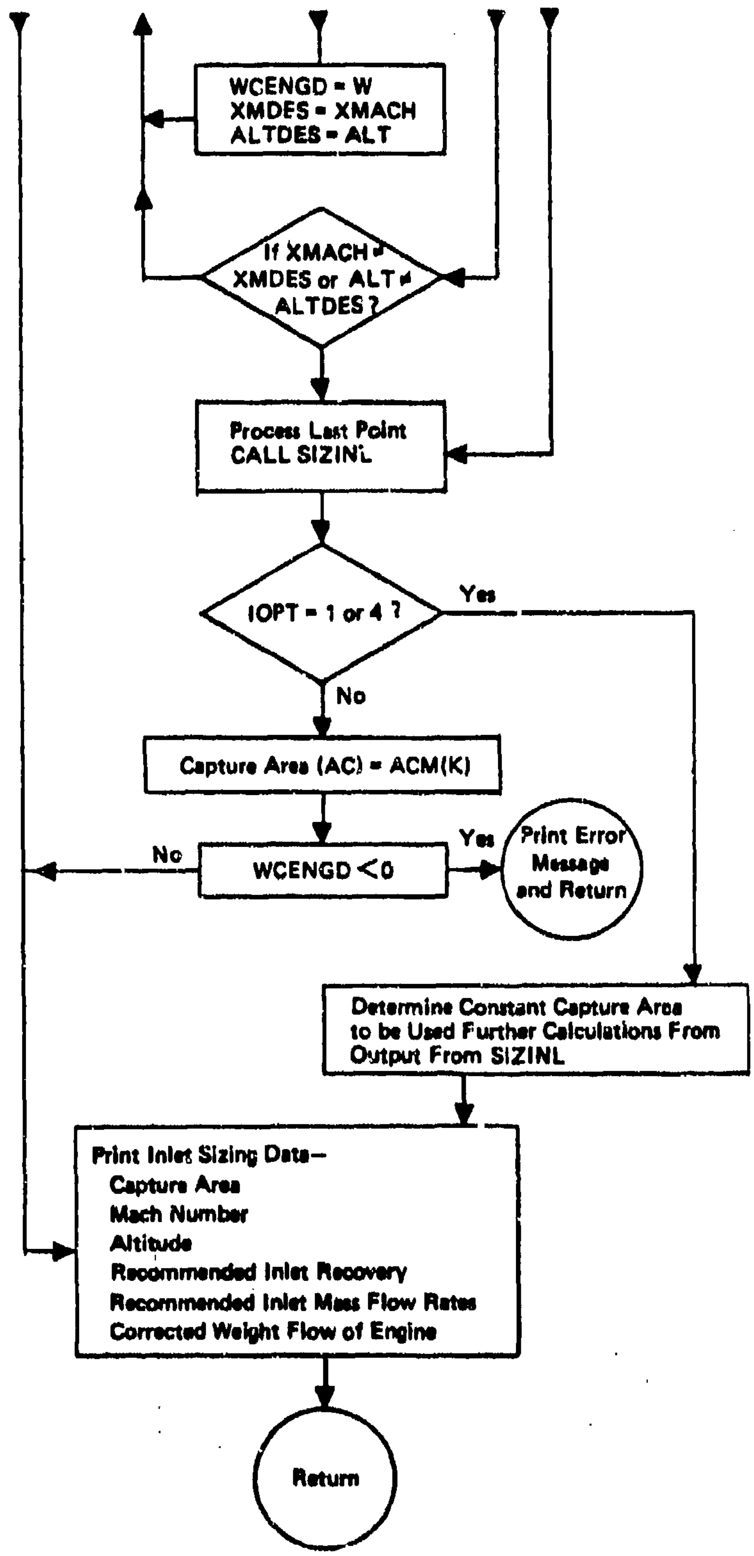

Figure 18. Subroutine RDATA (Concluded)

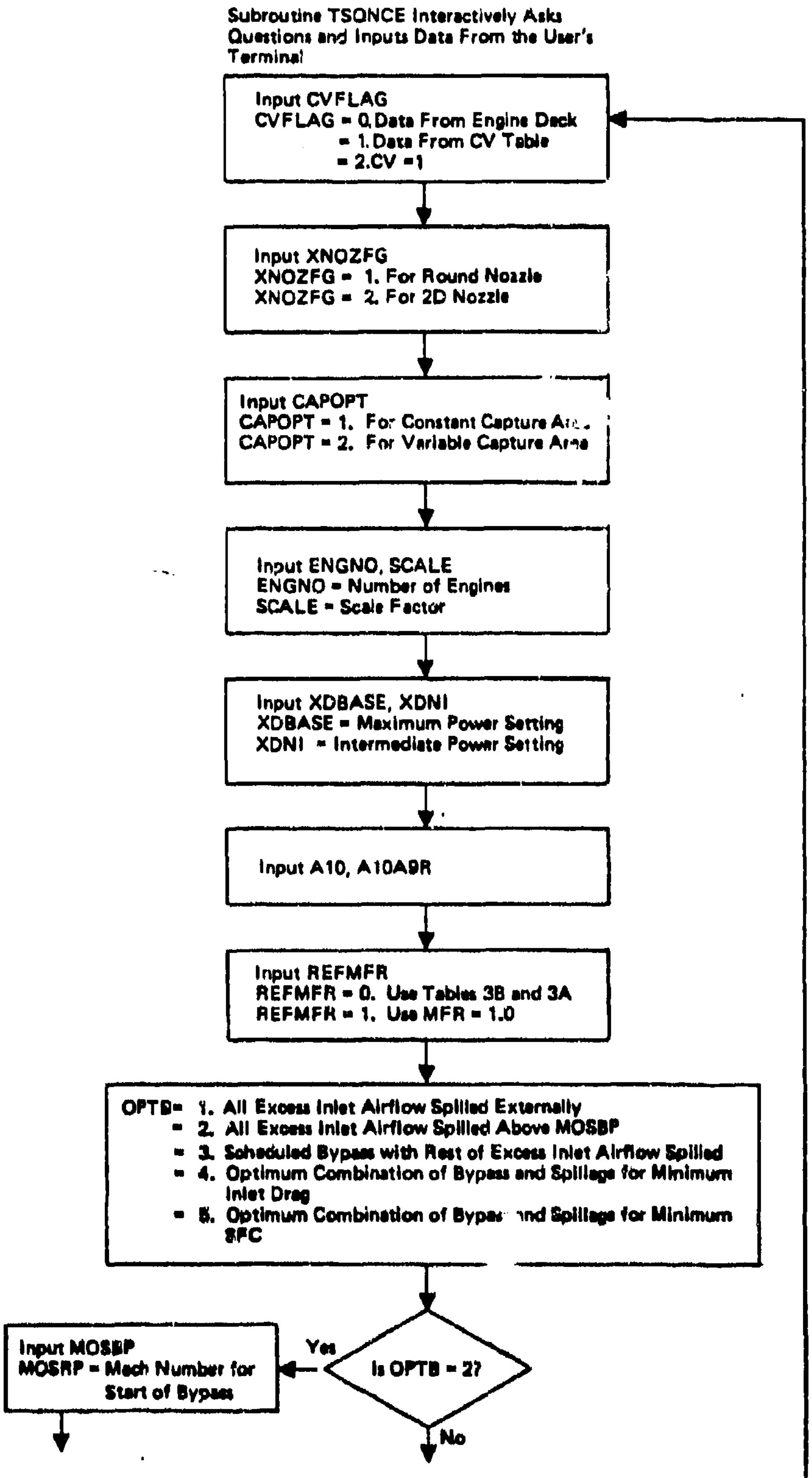

Figure 19. Subroutine TSONCE (Continued)

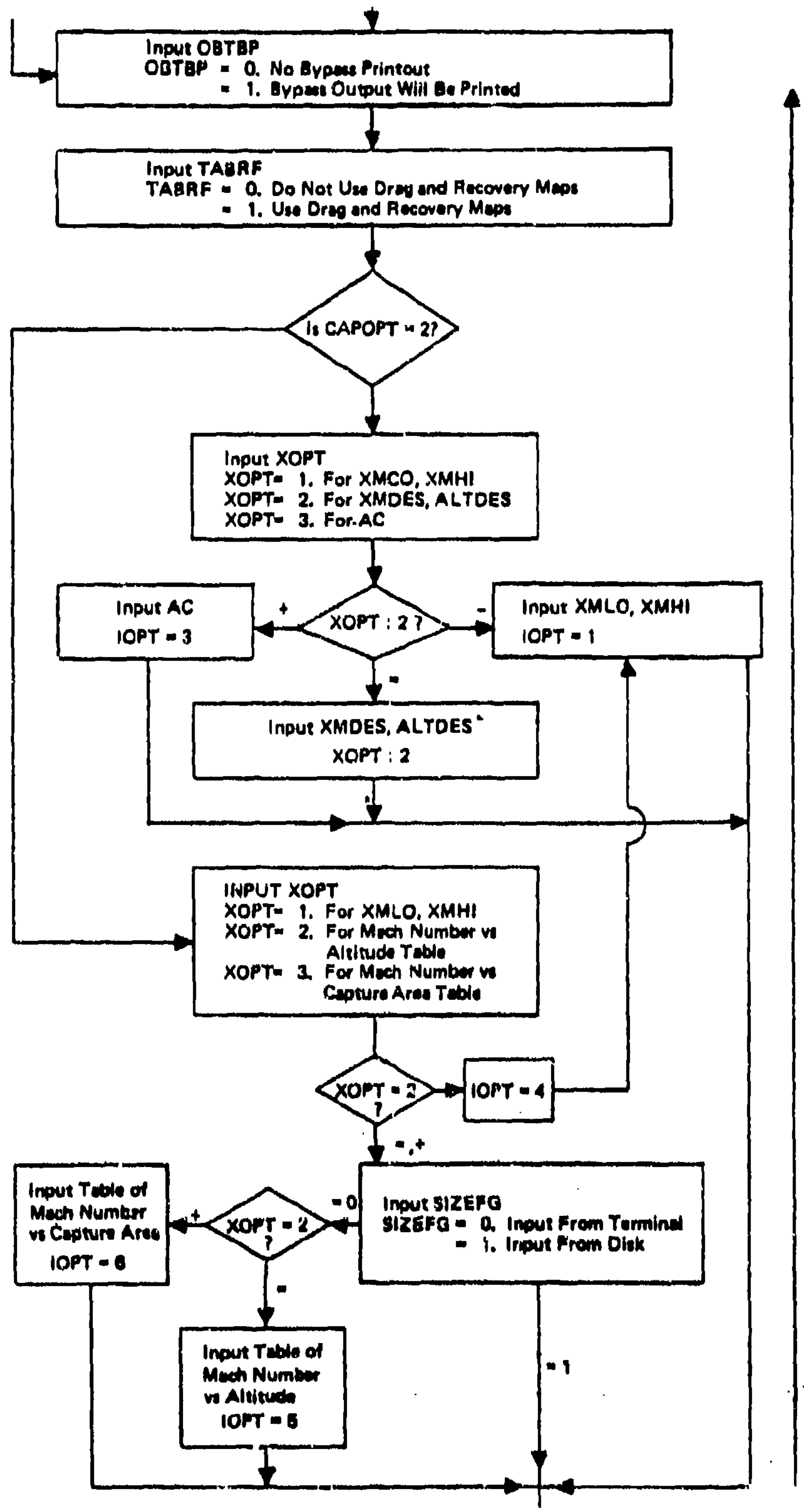

Figure 19. Subroutine TSQNCE (Continued)

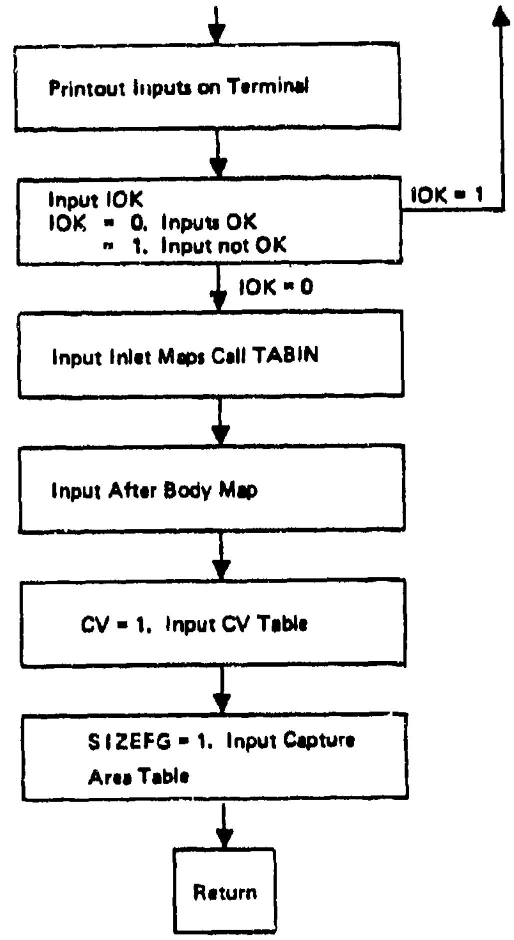

Figure 19. Subroutine TSQNCE (Concluded)

*U.S.Government Printing Office: 1978 — 657-002/164